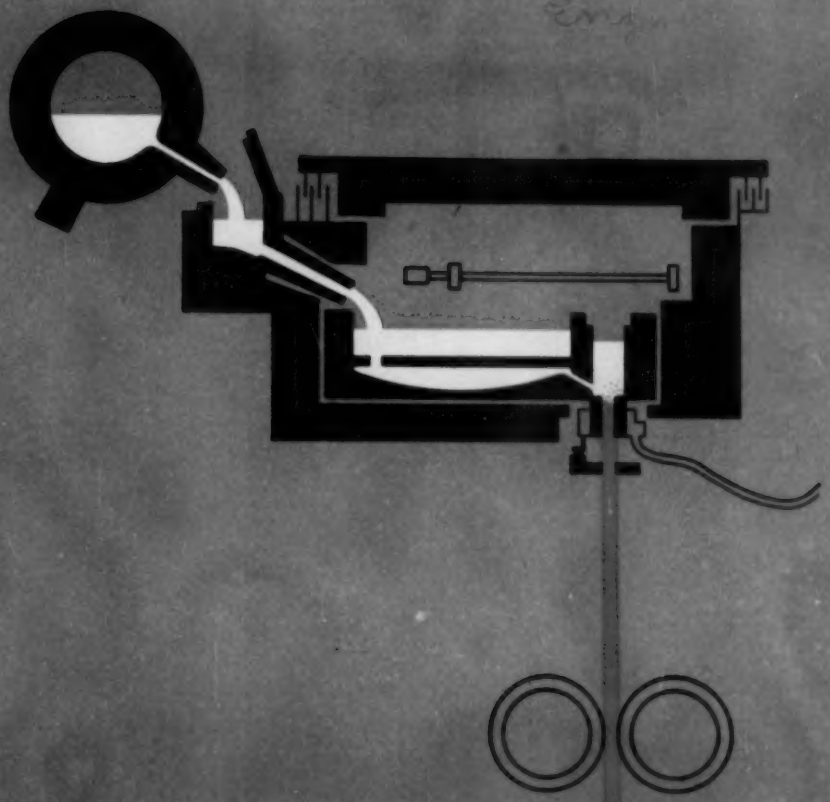
AUTOMATION

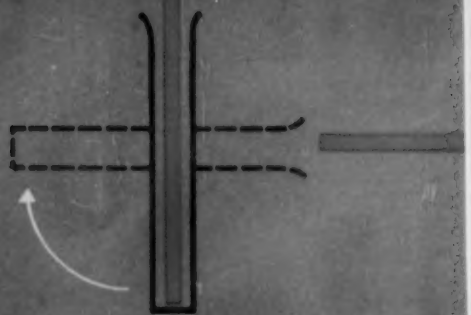
JULY 1956



NONFERROUS ROD AND TUBE

Continuous Casting

The Magazine of Automatic Operations



- **Tape Programed Conveying**
- **Selecting Liquid and Dry Feeders**
- **Gaging Memory Control**
- **Stamping Axle Housings**

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A PENTON PUBLICATION

The "NEW LOOK" in Production Stamping

AUTOMATION for the pressroom is just around the corner according to a number of the nation's leading press experts who have studied the revolutionary "Flying Press" approach recently announced by the Wean Equipment Corporation.

Taking a coil of steel directly from the mill, the Wean Flying Press Line decoils, levels, measures, blanks, sorts, counts and piles the finished piece on trans-car ready to be rolled to the next operation—at a speed heretofore considered unobtainable.

Present engineered lines will handle coils up to 72 inches in width—cutting lengths from 12 inches to 8 feet.

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AUTOMATION ®

THE MAGAZINE OF AUTOMATIC OPERATIONS

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automation outlook

MANUFACTURED AUTOMATICALLY

". . . probably no one group of individuals has a greater responsibility toward making automatic continuous production possible than those directly responsible for product design. It is no longer possible for the product designer to think solely, "Can this part be manufactured?" He must now consider, "Can this part be manufactured automatically, utilizing the best manufacturing processes, techniques, and equipment available?" There was a time when it was necessary for him to be familiar only with the functional requirements of the product and the styling that would be readily acceptable to the customer.. It is possible for the product designer to design a product in such a manner that the nature of the manufacturing process limits the product either to the manual or to the automated method of manufacture . . ."—*R. Ruszczak, Heald Machine Co.*

FAVORABLE TO ECONOMIC GROWTH

". . . taking recent developments all together, it is reasonable to expect that high levels of production, employment and income will be broadly sustained during the coming year, and that underlying conditions will remain favorable to further economic growth . . ." *Dwight D. Eisenhower, President of the United States.*

SILENCE IS NOT ALWAYS GOLDEN

". . . it's easy to trace the line of thinking which leads to the conclusion that to be mute is to be safe. It's also easy, although less so, to sympathize with those who profess to believe in muteness, since we have all been exposed to the same huddle of shivering and ill-formed myths about "Man, A Slave To The Machine and Other Obscenities", or "Down With The Wheel, The Sled Builder Has To Live". What isn't easy to see in this doctrine of voicelessness, is anything other than a short term and apparently expedient solution to what its proponents consider to be a problem. Not talking about a time bomb doesn't make it tick any less quickly. And unfortunately automation has been made to look like a time bomb to a lot of people, including some who should know better . . ." —*Donald M. Swarts, secretary, Automation Industries Inc.* *See Pg. 28.*

NO THINKING WHATEVER

". . . within the last two years, much has been printed about giant calculators and large scale accounting machines, but very little about the people who run them. References have been made to giant "brains", when actually such machines can do no thinking whatever. They are morons without even sense enough to stop unless they are told—and, if wrong information is fed into them, they will produce errors faster than they have ever been produced before . . ."—*James A. Dollard, manager, Customer Administration Program, Department of Education, International Business Machines Corp.*

MECHANIZATION OF OFFICE PROCEDURES

". . . savings in cost, due to automation on the production line, have been quite obvious as well as substantial, and in a competitive economy efficient management has had no choice but to go ahead and make the savings. Possible savings from mechanization of office procedures have been somewhat more obscure and have not given the same incentive to office management. However, digital computers—small, medium, or large —are in my opinion, the means whereby American business can become just as automatic in the office as it is on the production line . . ."—*Robert E. Slater, vice president, John Hancock Mutual Life Insurance Co.*

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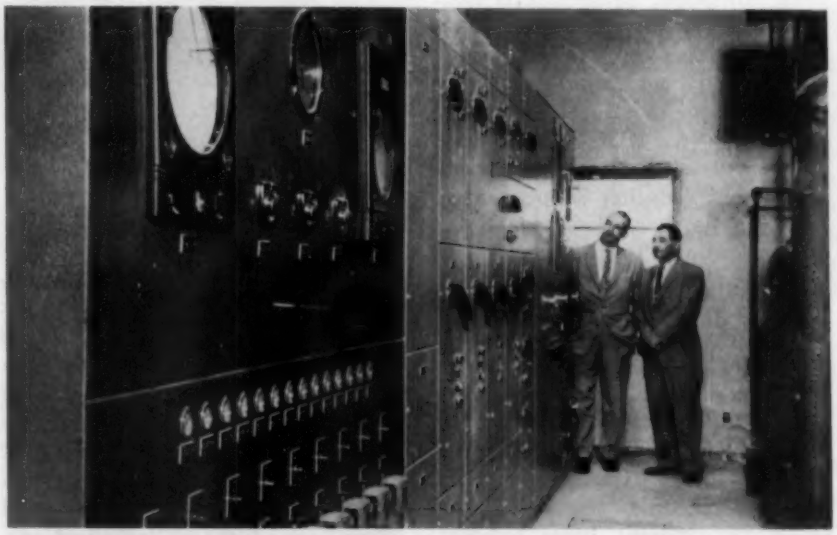
AUTOMATION news

Today's events and developments in the field of automation

Compound Compression Creates Practical Heat Pump System

HEAT pump system capable of heating a building using freezing or below freezing winter air processed by the same refrigeration system used to cool the building during the hot summer months has been developed by the York Corp. No supplementary heating system is necessary. The first application of the new system is presently functioning in a department store and another is being installed in a new office building.

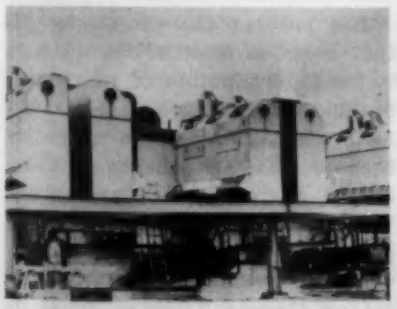
Although a number of leading companies including York have developed various types of heat pumps in the past few decades, no one previously has been able to create a heat pump that could operate economically using outside air at temperatures much below freezing. With outdoor temperatures colder than this, expensive supplementary electric resistance heating had to be used to warm the building. This fact relegated practical use of the air source heat pump to the more temperate climates.



AUTOMATIC controls in the York Corp. new compound compression heat pump system keep inside temperature at desired level. Pictured is a control center for a commercial building installation which will be heated and cooled with same system without the use of any supplementary heating equipment. Foreground shows Minneapolis-Honeywell temperature controllers; General Electric motor control center is adjacent.

The new development does away with the need for supplementary heating by making use of a long-known refrigeration technique—compound compression — which has been used for years to achieve economically the extremely low temperatures used in ice cream plants and the frozen food industry. Using only the electricity needed to run the compressors, which form an integral part of the basic refrigeration unit, the York heat pump can remove heat from zero degree outside air while cooling this air to still lower temperatures as it passes over specially designed coils. The heat removed by the refrigerant from the outside air, is elevated to a usable temperature level by the compression cycle. This heat can be used to produce hot water, which can be circulated throughout the building in an indirect system, or the hot refrigerant can be used directly in coils to provide forced warm air heating through either a central unit or multiple units.

During warm weather, conversely, the expansion, or cooling effect as the refrigerant turns from liquid to gas, extracts heat from the water circulated through the refrigerant. The resulting chilled water is piped to the same coils and cools air blown through these coils. The heat pump system automatically heats or cools the rooms in a building, depending on the climatic conditions, and always provides the desired room temperature. Thermostatically controlled valves guide the hot or cold water flow in and out of the system while



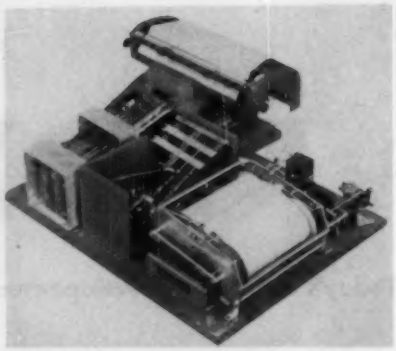
IN COMPOUND compression heat pump system, evaporative condensers serve normal use in summer; in winter, with specially designed refrigerating coils inside, the units are used to cool frigid air to even lower temperatures.

the compressors automatically move from single-stage compression into compound compression when the temperature drops below a certain point.

Data Processing Equipment Hub of Naval Support Program

THE NAVY has demonstrated how data processing equipment is used to provide the thousands of Naval aircraft based around the globe with parts and equipment they need, when and where they need them. An IBM 702 electronic data processing machine aboard the Navy's Aviation Supply Office, Philadelphia, was a key part in the demonstration. The ASO operation is one of the largest inventory control problems ever to be turned over to an electronic computer.

The jet age has multiplied the problems of supply many times. A typical jet aircraft has over 33,000 different parts, many of them peculiar to that type of plane. At the present time, the Navy has about 75 different basic aircraft models—jets and other types—and equips them with a variety of about 30 engines. This amounts to approximately 450,000 different items that the ASO in Philadelphia must keep track of.



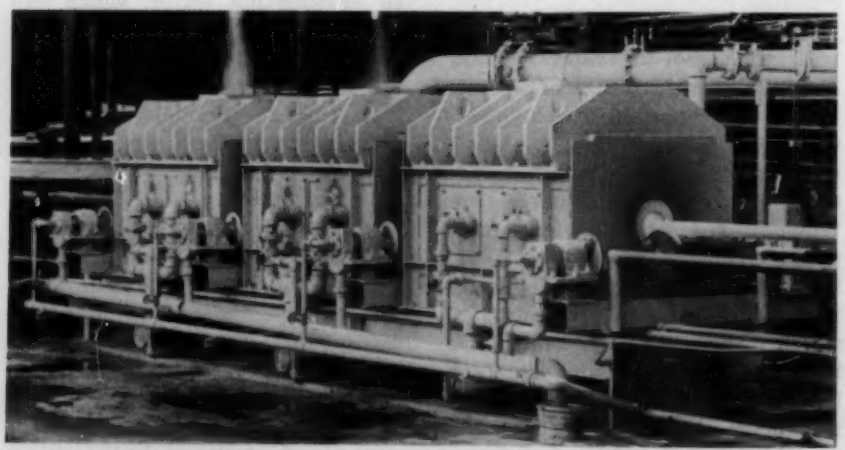
TESTER has been developed by American Automatic Typewriter Co. which automatically presents individual machines with series of problems to solve. The equipment simulates actual hand-key operations which an operator would perform. This is accomplished through pneumatic bellows that open and close according to coded perforations on a problem record roll. Series of problems takes 40 minutes, and the tester automatically adjusts its feeding of individual problems to a machine as it completes each preceding problem.

These quantities alone are enough to produce a highly complex supply problem, but they tell only part of the story. The hundreds of thousands of parts are stocked at more than 60 separate shore-based locations, many of which directly supply aircraft carriers and other ships at sea. And there are further complications. An aircraft, in ASO parlance, is a "gypsy." It may be in any part of the world from week to week. Wherever it goes, however, parts must be quickly available. This would be no problem if huge stocks could be held at each base; but in the interest of economy each base should have only what it needs, and nothing more. This means that a support program must be planned so that critically needed parts arrive at the proper base in correct quantity before the aircraft flies in.

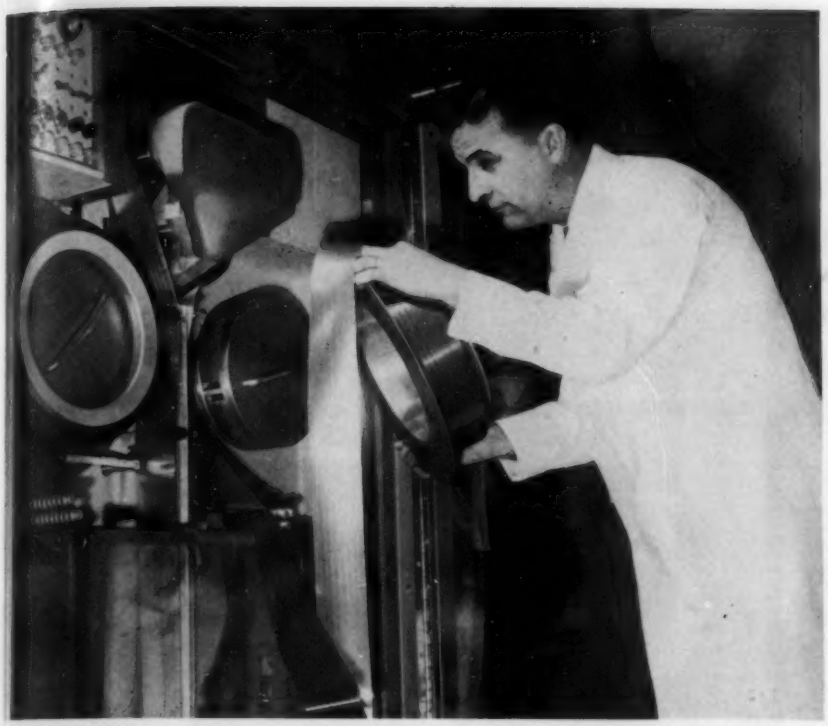
To solve this immense problem, for certain categories of material, in what is called the "Program Usage Replenishment System," the Navy has devised a widespread information-gathering system which has at its hub the IBM 702 in Philadelphia. From each of the stocking points to be supplied comes an up-to-date report as to what is on hand. From the Chief of Naval Operations comes a schedule of where every Naval airplane will be for the next several months and expected number of hours of flight, overhaul schedules, etc. And from maintenance officers throughout the Navy come regular reports telling how often each part is actually used.

The man in the field no longer has to guess or compute what he needs. He simply reports what he has on hand to Philadelphia. An answer comes back telling him what he will receive to meet his demands, where it will come from, and what he should ship to other locations so he can get rid of his overages and help others meet their demands. Previously, when this was handled on conventional punched card equipment at the ASO, it took an average of 90 days from the time the man in the field sent in his report until he got his answer. Now, the complete cycle averages only 43 days, a 50 per cent reduction.

The part of the processing job that requires most of the 43 days is the determination of what shall be shipped from where to where. At present, this is done by people because the ASO believes it requires a considerable amount of judgment. These people study the differences between supply and demand that exist at all points, and act on these differences by shifting stocks around or by buying more. For example, it might be feasible to use fuel controls being held at one base to fill a need else-



NORMALIZING line including three small gas furnaces, instrumentation, and variable-speed conveyors is automatically controlled and charged. Designed by National Supply Co., the line is used for continuous normalizing of small sizes of oil well tubing. In charging, the tubing rolls by gravity to a stop where a pneumatic operated mechanism, initiated by preceding work entering the furnaces, picks up a length of tubing and rolls it onto the furnace inlet table. Powered rollers feed the furnace. Tubing at outlet is similarly discharged to a cooling table. Approximately 1000 tons of tubing are normalized per month.



CO-ORDINATED data processing system employing high-speed computer principles has been engineered by Datamatic Corp. Unit is specifically designed for business uses which involve a great mass of data, the need for fast input, minimum computation and fast outputs. Input to magnetic tape is at rate of 900 punched cards per minute. One reel of tape can store over 37 million decimal digits of information. Output on cards is at rate of 100 per minute or typed reports can be prepared at rate of 900 lines per minute. Building block arrangement of equipment permits incorporating of as many as 100 tape units into an installation, any one of which can be referred to without disturbing the rest of the system.

where, rather than hold them until future scheduled moves of aircraft take place. The demand in some cases can be supplied directly from the manufacturer more conveniently. Also, transportation costs and times must be weighed and considered carefully. New mathematical techniques demonstrate that at least some of these processing steps might be handled successfully on a computer, but it will be some time before definite steps in this direction are taken.

As a result of the same data processing operation, other significant reports are automatically produced. Four major examples are: (1) A procurement analysis which tells how many items (fuel controls, for instance) will be needed in the next several months. The number of months depends primarily upon the manufacturers' lead time. For some items difficult to manufacture, the Navy must place its order as much as 36 months in advance; (2) A report on retention and disposal quantities. This tells the total number of the item that will ever be needed. It leads to large economy purchases, or to disposal of obsolete materials, both of which actions save the Navy money; (3) Catalogs giving parts lists and technical and engineering information; and (4) Schedules sending worn material to repair shops and sending spare parts to the shops so they arrive concurrently with worn carcasses.

Temperature Control In Transistor Manufacture

SAPPHIRE rod pyrometer control system has been developed by Minneapolis-Honeywell Regulator Co. in co-operation with Philco Corp.'s Research Laboratories. Purpose of the new electronic temperature control system is to improve production of silicon crystals used in the manufacture of transistors.

Conventional control methods use thermocouples that react slowly and burn out quickly under the high temperature conditions necessary for growing silicon crystals. In the new control system, the sapphire rod (a single, pure crystal of aluminum oxide, ⅛-inch in diameter and about 12 inches long) acts as a transmission line for infrared rays. The rod is focused on the bottom of a crucible holding the molten silicon used in crystal manufacture. Radiant energy is transmitted back through the rod to a thermopile which relays the findings to the control system proper which adjusts the furnace temperature by regulating the power fed to the furnace. The furnace is either an induction or resistance type.

The radiation control system eliminates the measuring lag characteristics of thermocouple systems and also provides an average measurement of the molten silicon temperature as contrasted to the measurement of a single point. The sapphire rod is expected to have an appreciably longer life than the thermocouple type sensing units.

APPOINTMENT of **W. F. Lent** as vice president in charge of manufacturing and **R. A. Millermaster** as vice president in charge of development has been announced by **Philip Ryan,** president of Cutler-Hammer, Milwaukee electrical firm.

Both Lent and Millermaster hold electrical engineering degrees from

W. F. Lent

the University of Wisconsin. Lent began his career at Cutler-Hammer as an application engineer and in successive appointments was named manager at the firm's molding department and later production manager. In 1950, he became works manager and held that position until his appointment as vice presi-

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Read-out to auto-typewriter or tape puncher
Sequence batcher for manual programming
Punch card operated sequence batcher
Desk instrument for weighing
Desk instrument for weighing and printing

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The Fairbanks-Morse line of electronic instrumentation performs many functions beyond the elementary process of weighing. It will, for instance, register and record weights at a remote location. It will perform automatic sequence batching—say, from a punch card. It will translate weight messages into the language understood by automatic typewriters, automatic adding machines, tape punchers, other data processing machines. It will control a complete plant materials flow program.

This instrumentation is now available with Fairbanks-Morse truck and track scales, axle-load scales, warehouse and portable scales, and many other types of weighing machines.

The weight message is created in the electronic load cell. Fairbanks-Morse employs it in two ways. The *Full Electronic* system utilizes multiple load cells. In the *Levetronic* system, a single load cell is incorporated in a conventional lever system. (Your present lever scale can probably be converted to *Levetronic*.)

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R. A. Millermaster

dent in charge of manufacturing.

Millermaster joined the company as test engineer in 1927. In 1933, he was named development supervisor, assistant manager of development in 1948, and in 1952, manager of development, the post he held at the time of his appointment as vice president in charge of development.

Synthetic Fiber Use Expands To Bearing Field

DESIGN of bearings not requiring lubrication is possible with use of Teflon fiber woven into fabric. In one example, the use of the fabric to face metal suspension joints, in addition to functioning without customary lubrication, reduces the amount of friction by more than 50 per cent in comparison with standard lubricated suspension joints used in automobiles.

Developer of this use for Teflon fiber is the American Metal Products Co. of Detroit, manufacturer of automobile and aircraft parts, materials handling equipment, and plumbing fixtures. Du Pont, originator of Teflon, co-operated in developing this use for the synthetic fiber.

Use of Teflon tetrafluoroethylene fiber in a ball-and-socket suspension joint is achieved by double weaving it with a backing of nylon or cotton. This fabric is then laminated with cotton-reinforced phenolic resin and formed into a cup which lines the socket. Metal parts are coated with a special grease to prevent corrosion. The joint is assembled and the preformed bearing is molded in place, assuring a perfect spherical contact between the ball stud and the bearing. The joint is then sealed. Preliminary testing indicates that these bearings will last the lifetime of the automobile without lubrication or other maintenance. Studies also indicate that there will be no increase in original cost over a standard joint.

Many other frictional applications of Teflon fiber which may eliminate the need for conventional lubrication are under development. These include: (1) Spherical parts such as rod ends and ball-socket joints for special controls and self-aligning bearings; (2) cylindrical parts such as seals, bushings, pistons, and sleeve bearings for all types of machinery, marine propeller shaft bearings, and steel roller mill bearings; and (3) flat or sliding parts, such as leaf-spring end pads and slider beds for adjustable seats and conveyor belts.

Punched Plastic Cards

MANUFACTURER of plastic specialities for both technical and commercial use, the Sillcocks-Miller Co., has announced its entrance into the field of electronic timing systems with the manufacture of printed and punched plastic cards for use in programming operations.

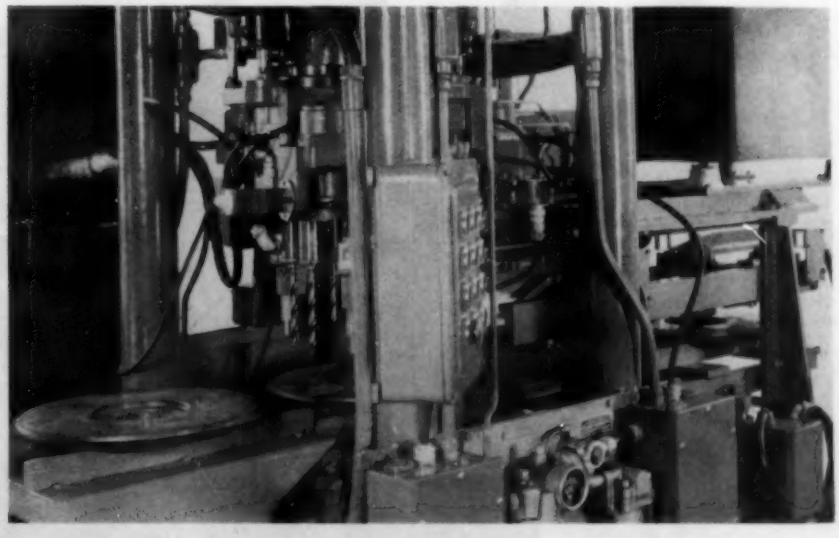
Plastic cards can be made in any length to meet specific applications. For instance, in one design a card has 700 rows of holes with each row containing 85 possible punch points. This specific design allows programming of 700 individual test setups with 85 test points in each setup. Or with a single time-based programmer, each of ten external circuits can be selectively energized for any period of time from one second to 30 hours.

AIEE Creates New Division

BECAUSE of the increased importance of instrumentation, a sixth major technical division of the American Institute of Electrical Engineers, to be known as the Instrumentation Division, has been approved by the Board of Directors, **N. S. Hibshman,** Institute secretary, has announced.

The new division, of which **C. F. Savage, Jr.,** General Electric Co., New York, has been named chairman, will begin operations as a division August 1. At present it is part of the Science & Electronics Division, and is known as the Committee on Instruments & Measurements.

Present subcommittees on indicating and integrating instruments, recording and controlling instruments, electronic and high frequency instruments, special instruments and auxiliary apparatus, telemetering, nucleonic and radiation instruments and navigation instruments, will become commit-

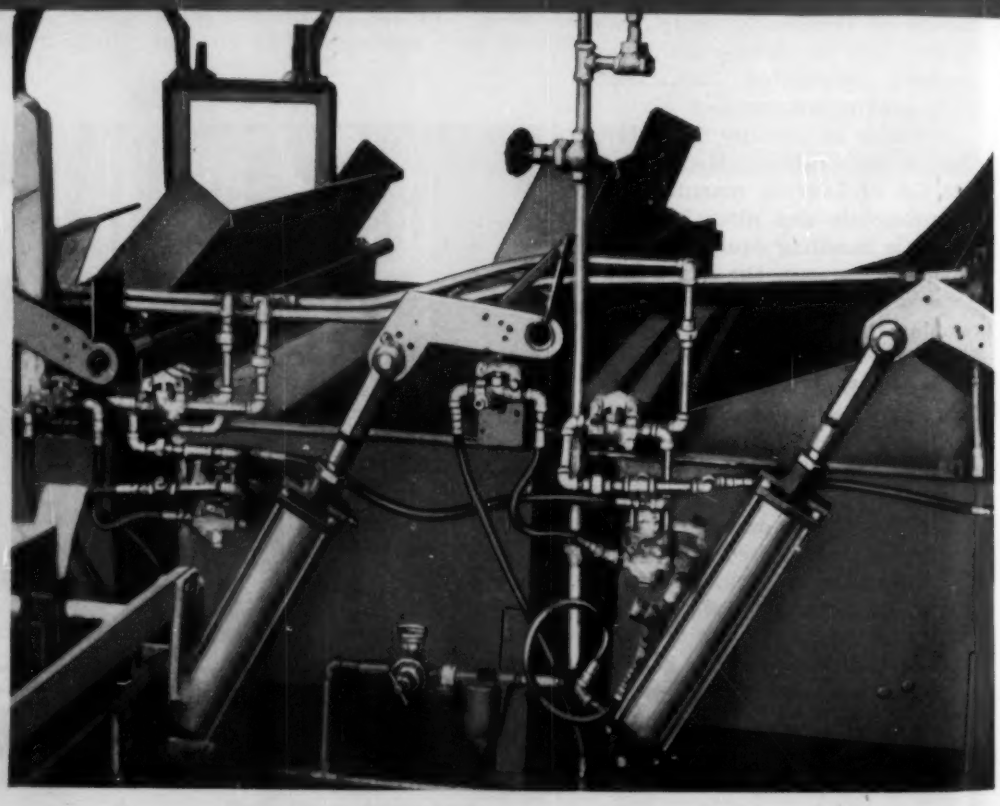


AUTOMATIC machine which balances flywheels at rate of 125 pieces per hour has been designed by Micro-Poise Engineering & Sales Co., Detroit, Mich. The machine locates, measures, and corrects unbalance without an operator's attention. Fundamental design of the machine permits its use in various similar situations where the removal of material for balance may be limited to certain locations on the workpiece.

1

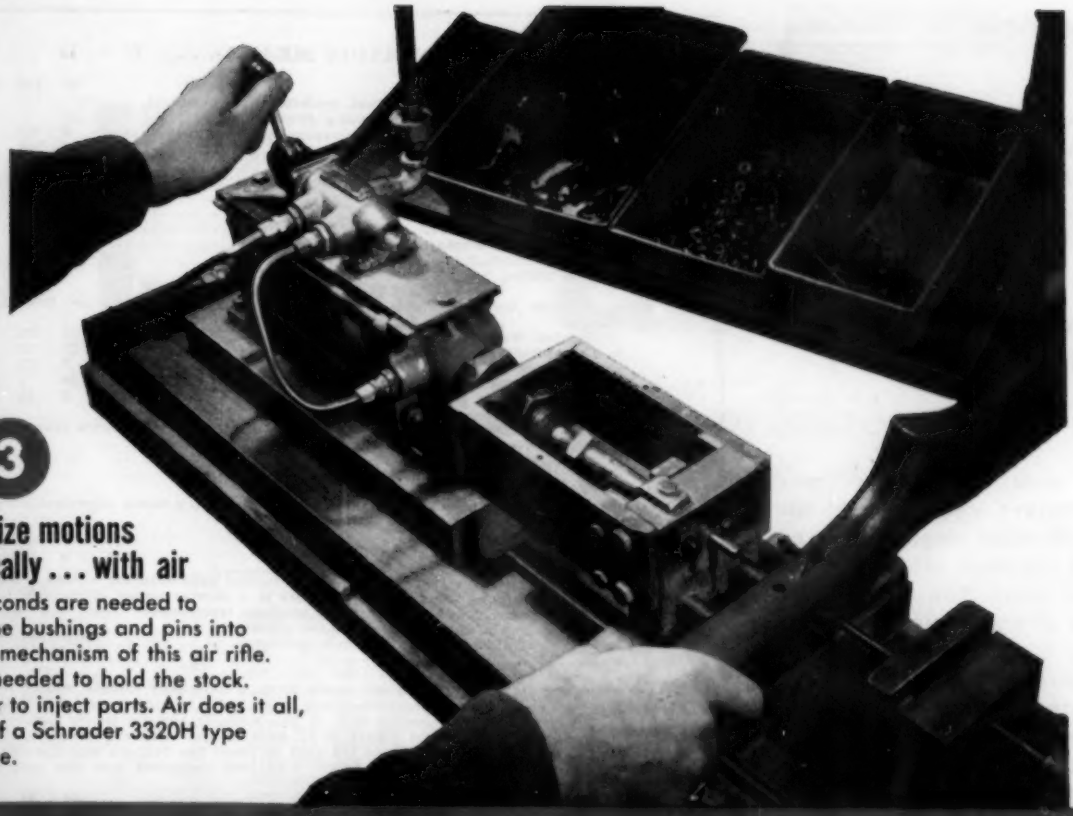
Hold and position work...with air Here, Schrader Air Products are used to hold burner grills and bend them into shape with a ton of force. Before air was adapted to the job, only 150 pieces were produced per hour. Now, with air, 620 pieces are produced in the same time.

AUTOMATE...



2

Move work...with air In this particular adaptation, plated parts are automatically washed three times. Air products lift the baskets, immerse them, lift again, and transfer them to the next bath. Operator simply presses button to start the sequence of interlocked cylinders and controls, all developed by Schrader.



3

Synchronize motions automatically . . . with air

Only 40 seconds are needed to assemble the bushings and pins into the trigger mechanism of this air rifle. No vise is needed to hold the stock. No hammer to inject parts. Air does it all, by means of a Schrader 3320H type 4-way Valve.

. . . WITH AIR!

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Few plants exist which do not already benefit from the speed and economy of air for all types of simple operations—from inspecting and assembling to testing and packaging. But just imagine how this speed and economy multiplies its benefits when air is applied to the more complex operations required by automation!

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tees under the new setup. Other technical divisions of the Institute are those on Communications, General Applications, Industry, and Power.

Opinions on Automation Outlined In Special Survey

By R. E. SULLIVAN
Chairman, Dept. of Commerce
University of Wisconsin

WHAT does "automation" mean to the worker, employer and educator? No other single subject has received any more attention in the past two years than automation—yet with all the writing and speaking that has been done, it is still a controversial subject. Like so many other subjects of interest and importance, this one has been thoroughly discussed via the medium of "talking to ourselves." And consequently, some of the most critical issues involved could be missed.

Eighteen months ago the writer, with the help of three graduate students, set out to sample some opinions of people in the broad area of automation, its meanings and implications. We didn't enter into this survey without a bias; as a matter of fact, we assumed that there was a sharp division of opinion between the groups to be studied, and we structured our questions to crystallize this division if it did exist.

Four easily identified groups were questioned: Members of management, organized labor, nonorganized labor, and high school and university faculty members; approximately 4000 answers were received which were distributed as follows: Management, 1100; organized labor 1400; nonorganized labor, 700; and educators, 800.

Twenty questions were asked of each participant. Eight of the questions and the responses that were received are shown in the accompanying table. In the table, the responses for the four groups (M-management, OL-organized labor, NOL-nonorganized labor, E-educator) are shown as percentages of the total of the given group which favored the indicated answer. Note the answer to question 7. The quotation is actually by Philip Murray as reported by B. J. Fairless.

AUTOMATION MEANS . . . . ?

		M	OL	NOL	E
1.	Which of the following phrases best describes automation?				
	a. Scientific approach to increasing production	48	18	31	39
	b. A method of using machines to reduce the need for workers	0	42	17	21
	c. Utilization of machines to reduce cost	52	40	52	40
2.	What phrase from the list below do you most readily associate with your understanding of automation?				
	a. Higher standard of living	72	41	58	52
	b. Lower costs	10	4	6	16
	c. Danger of unemployment	1	37	14	10
	d. Higher production	10	10	12	12
	e. Less skilled work	7	8	10	10
3.	What in your opinion is the best way for the employee to be protected from automation?				
	a. Shorter working week	27	31	37	39
	b. Guaranteed employment	28	32	31	31
	c. Severance pay	1	10	2	1
	d. Company planned program of "machine replacement"	36	3	17	19
	e. Stronger union representation	8	23	13	10
4.	If you are a member of a union, do you feel that this membership takes on greater importance in view of the approach of the automatic factory?				
	a. Yes	—	91	—	—
	b. No	—	9	—	—
5.	If you are not a member of a union, do you feel that a union organization would be helpful to protect you in the future?				
	a. Yes	—	—	69	—
	b. No	—	—	31	—
6.	Accelerated depreciation (rapid write-off of capital expenditures) allows companies to charge the cost of new machines as expenses in a shorter period of time than normal. This in turn makes possible more rapid machine replacement. From the viewpoint of the employee, do you think this is a good practice?				
	a. Yes	87	31	56	54
	b. No	13	69	44	46
7.	The following statement is a direct quote from a nationally known leader: "I do not know of a single, solitary instance where a great technological gain has taken place in the United States of America that it has actually thrown people out of work. I do not know of it, I am not aware of it, because the industrial revolution that has taken place in the United States in the past 25 years has brought into the employment field an additional twenty million people." In your judgment was this man a leader of industry or labor?				
	a. Industry	88	91	87	32
	b. Labor	12	9	13	68
8.	Do you believe that increasing mechanization of office activities will cause greater interest in unionization among office employees?				
	a. Yes	67	94	81	84
	b. No	33	6	19	16

The divisions of opinion and differences in understanding are quite obvious—and in the writer's judgment even more significant. The four groups represent very important segments of our society. Each has a different function in this era of technology. Management must decide how and when to use the potential benefits of automation; organized labor must decide what it means to its function and how to deal with it; nonorganized labor must decide what automation's implication is to it—and whether union representation is desirable; and finally, automation offers a real challenge to the educator—not only in terms of preparing young people to achieve successful adjustment in this day of technological progress, but to train people in the new knowledge and skills required by the advent of automation.

If this is a fair judgment of the roles of these groups, then it seems logical to assume that their actions should in general be based upon a sound and similar basis of what automation is and what implications it has for the individual, the union, the company and the economy. The table gives some idea as to the areas of agreement and disagreement.

There are some leaders in our country who resent the suggestion that there is anything but good to come of automation—they heatedly bring forth statistics to prove that technological progress has created more jobs than it has ever destroyed—and this we grant is true, but this apparently means little to the individual who loses his job or feels that his security is endangered. The fellow in Madison, Wis. who sees his job threatened or taken over by a new mechanical device, is little comforted by the manager, the economist, or the educator who glibly points out that while this is happening, over five new jobs are being created at

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411	441	471	501	531	561	591	621	651
412	442	472	502	532	562	592	622	652
413	443	473	503	533	563	593	623	653
414	444	474	504	534	564	594	624	654
415	445	475	505	535	565	595	625	655
416	446	476	506	536	566	596	626	656
417	447	477	507	537	567	597	627	657
418	448	478	508	538	568	598	628	658
419	449	479	509	539	569	599	629	659
420	450	480	510	540	570	600	630	660
421	451	481	511	541	571	601	631	661
422	452	482	512	542	572	602	632	662
423	453	483	513	543	573	603	633	663
424	454	484	514	544	574	604	634	664
425	455	485	515	545	575	605	635	665
426	456	486	516	546	576	606	636	666
427	457	487	517	547	577	607	637	667
428	458	488	518	548	578	608	638	668
429	459	489	519	549	579	609	639	669
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Keep Up-to-Date!

Paducah, Ky. Neither is he impressed by the approach of how grand this will be for the youth of tomorrow.

There are also those who would have you believe that automation is nothing new—just more of the same scientific progress at a more rapid rate. They may be right as far as they go—but there is something which is new and which must be considered. This is the force and effectiveness of organized labor in imposing its views upon industry and our total economy. Previously, there was no voice of the worker—except his own, but today we are well aware of the impact a small minority can have upon the desires and rights of the majority —especially, if it has money and organization.

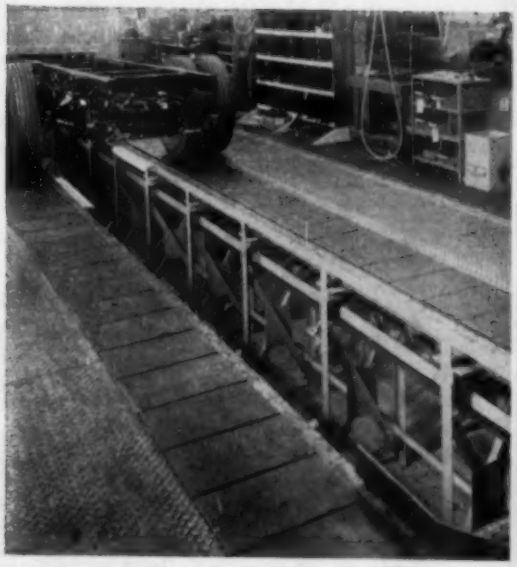
To further emphasize the importance of the difference in understanding which the survey shows, you have to look only at the effects (real or imagined) automation may have upon the policies and plans of organized labor. For instance, if automation, as this writer believes, will decrease the economic effectiveness of strikes, then it is not too difficult to predict an all-out effort at the organization of groups historically in sympathy with management. Parenthetically, it must be granted that this sympathy has in many instances been more historical than real.

The need is obvious and current. Who will take the leadership in exploring, explaining, and developing a knowledge of the impact of automation upon the American economy and its people. Idealistically, the groups mentioned earlier should do it jointly—but practically speaking, it's another job for the management of business and industry.

New Apprenticeship Programs To Meet Industries Needs

ONE of the first attempts by American industry to cope with the shortage of electronic engineers by training skilled craftsmen to take over some of their tasks has recently been described in the *Industrial Bulletin*, monthly magazine of the New York State Labor Dept., in an article dealing

NEW **Heavy Duty** CONVEYOR SYSTEM HANDLES 16 TON TRUCKS



Engineered and Installed by PLANET

32,000 pound gross weight vehicles are moved with ease on the assembly line conveyor recently designed and installed by Planet in a large new truck and bus plant. The complete Planet system includes sub-assembly lines which feed the main assembly line. This is in two units with a knife-edge type conveyor feeding onto a flat top assembly type conveyor (illustrated above.)

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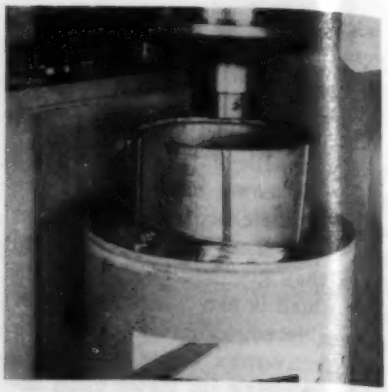
with the creation of a new apprenticeable trade called electronic laboratory technician.

The Edward Laboratories Co. of Wappinger Falls, N. Y., which registered the program, designs and manufactures electronic equipment used to test machine tool functions on automatic machines. It also builds electronic models designed to actuate tools in machines that are completely and semiautomatic. Many electronic engineers are presently used in tasks which do not require their full professional abilities. In order to supplement the electronic engineer, the proposed electronic laboratory technician will have to complete a four-year training program. It includes electrical shop work, basic electronics, circuit analysis and electro-electronic mechanical design.

Thomas L. Holling, chairman of the State Apprenticeship Council, for which the State Labor Dept. carries out the apprenticeship program, urged other industrialists faced with similar production and employment problems to investigate the possibility of taking the same action.

The *Industrial Bulletin* article also disclosed the creation of another new apprenticeship program for machine tool mechanic in the field of automation. The new trade, closely akin to the millwright occupation, will deal almost entirely with automatic machines capable of turning out a complete production job without human help except in the setup stage. It was registered by the Seneca Falls Machine Co. of Seneca Falls, N. Y., which provides machinery to industries converting to partial or complete automation.



SELF-FEEDING container for its wire products is being offered to wire formers by Scovill Mfg. Co. Copper base alloy wire made by the company feeds directly into a cylindrical container from the wire drawing machine at the mill. At the customer's wire forming machine, the wire can be made to feed continuously and smoothly directly from the same shipping container. Up to 500 lb of wire in a single strand is packaged in any one container. The standard packaging simplifies materials handling and provides users with a uniform, stackable container.

MEETINGS AND EVENTS

July 9-20—

Purdue University. Short course in linear automatic control system synthesis to be held Lafayette, Ind. Additional information may be obtained from Div. of Adult Education, Engineering Administration Bldg., Purdue University, Lafayette, Ind.

Aug. 21-24—

Western Electronic Show and Conference. Cosponsored by West Coast Electronic Manufacturers Association and Institute of Radio Engineers. To be held Los Angeles, Calif. Additional information may be obtained from Wescon, 344 N. La Brea Ave., Los Angeles 36, Calif.

Sept. 11-12—

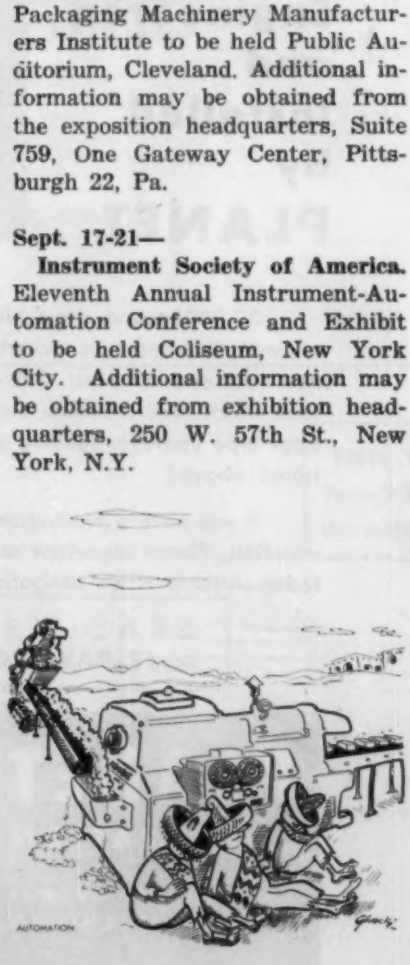
Radio - Electronics - Television Manufacturers Association. Second conference on reliable electrical connections to be held Irvine Auditorium, University of Pennsylvania, Philadelphia. Additional information may be obtained from J. A. Caffiaux, 650 Salmon Tower, 11 W. 42nd St., New York 36, N. Y.

Sept. 11-14—

Packaging Machinery & Materials Exposition. Sponsored by Packaging Machinery Manufacturers Institute to be held Public Auditorium, Cleveland. Additional information may be obtained from the exposition headquarters, Suite 759, One Gateway Center, Pittsburgh 22, Pa.

Sept. 17-21—

Instrument Society of America. Eleventh Annual Instrument-Automation Conference and Exhibit to be held Coliseum, New York City. Additional information may be obtained from exhibition headquarters, 250 W. 57th St., New York, N.Y.



Sept. 24-28—

Trade Fair of the Atomic Industry. Sponsored by the Atomic Industrial Forum Inc. to be held Navy Pier, Chicago. Additional information may be obtained from the sponsor, 260 Madison Ave., New York 16, N. Y.

Oct. 1-3—

Twelfth Annual National Electronics Conference and Exhibition. To be held Hotel Sherman, Chicago. Additional information may be obtained from G. J. Argall, DeVry Technical Institute, 4141 Belmont Ave., Chicago 41, Ill.

Oct. 3-5—

Standards Engineers Society. Fifth annual meeting to be held Hotel Willard, Washington, D. C. Additional information may be obtained from the society, P. O. Box 281, Camden, N. J.

Oct. 9-10—

Illinois Institute of Technology. Conference on computer applications. To be held Chicago, Ill. Additional information may be obtained from J. J. Kowal, Armour Research Foundation, 10 W. 35th St., Chicago 16, Ill.

By JAMES C. KEEBLER
Associate Editor

Moderators for the Second Production Machine Tool Hydraulic Forum held in Detroit were (left) R. L. Dustman, productive equipment manager, Chevrolet Div. GMC; and (right) Hans Ernst, director of research, Cincinnati Milling Machine Co.

Hydraulic Town Meeting

HYDRAULIC SYSTEMS offer one method of supplying controlled power for the motions required on production equipment. A bill of material for a particular 150-foot long transfer machine for automotive parts, for instance, is known to include 20 hydraulic power units, 73 hydraulic cylinders, 184 hydraulic valves, and 7000 feet of hydraulic tubing.

Though they are oldtimers in the hydraulics business, the people at Vickers, Inc. have this thought: "While oil hydraulics is of vital importance to the mass-production industries, the art is still so young that there is a lack of common understanding of many important details of its application. This occurs among users and builders of hydraulically operated machinery as well as among manufacturers of accessories and fluids for these machines." Based on that thought they sponsored their Second Production Machine Tool Hydraulic Forum.

Many a good nugget of knowledge has been uncovered in an old fashioned bull session; so a meeting that would promote discussions was calculated to yield ideas for improvement of hydraulic products, system designs, and maintenance methods. Participants included 68 men from the auto industry, primarily representing plant engineering and master mechanics departments; 6 men from other high-volume production industries; 71 engineering personnel concerned with hydraulic systems from original equipment machine tool builders; 18 technical personnel of hydraulic accessory manufacturers; and 30 key Vickers personnel from engineering and product service departments.

Hydraulic Problems

In his keynote address to the conference, Sheffield's president Louis Polk, currently president of the National Machine Tool Builders Association, remarked how hydraulic controls have helped provide modern machine tools with built-in operating skills, and having infinitely variable speeds and feeds (in certain ranges) that change automatically at predetermined points in the machining or measuring cycles. Such machines load, clamp, unclamp and unload themselves, inspect their products and make adjustments.

In speaking of machine tool improvements the keynoter went on to comment: "And so, too, the machine tool's hydraulic components continue to be greatly improved, although you have not permitted this to develop complacency. In fact, I believe you will be interested in the areas for improvement as relayed to me by a number of your and my friends active in hydraulic engineering in the machine tool industry. They confirm the forthright purpose of this Forum to inform and progress together.

"I suppose heat elimination will always be a problem in machine tools. Heat in the hydraulic lines, pumps and valves is particularly critical on precision machine tools because, like heat from any other source, it can impair accuracy. Too, a heated piston naturally tends to change the rate of feed . . . and uniform feed is becoming more and more essential in machine tools, especially for automatic operations where certain co-ordinating and dovetailing movements must be perfectly timed with each other . . . It would be helpful for machine tool engineers to be able to use designs that permit feeding through orifices in either direction. They also would welcome improved control of viscosity. And if there were standardized valve mountings, as there are electric switch mountings, the resulting interchangeability would please both the machine tool manufacturer and his valued customers."

Working to an agenda that had been prepared from suggestions submitted in advance by the participants, the moderators read each point in turn and called forth the prepared comments before the general open discussion of that point.

Lack of common understanding of the application of hydraulic systems to production machines was cited at this Forum as the number one holdback of more widespread use. Runner-up on the

reason list is the problem of leaks. Fitting designs discussed included: Flareless tube fittings, flanged plate mountings, mismatched taper pipe threads, Tru-Seal nuts with integral Teflon seal for tapered pipe threads, and a newly proposed SAE standard fitting with straight threads sealed by an O-ring under the hex of the fitting (similar to the AN standard used in aircraft).

Consensus of opinion seems to be that parts, made to the specifications of any of these designs, that are properly assembled by competently trained personnel will result in leakproof joints. The big standardization problem is to choose the design combinations least likely to leak when put together carelessly by those not experienced with hydraulic problems.

Hydraulic systems on machine tools must not only be assembled properly on the builder's floor, but must be designed with an eye toward maintenance. Shock conditions in tubing runs create a need for adequate hydraulic tubing hangers and supports. No rule was laid down for all cases, but the need for design consideration of vibrations that cause leaking points to a market for commercial supports.

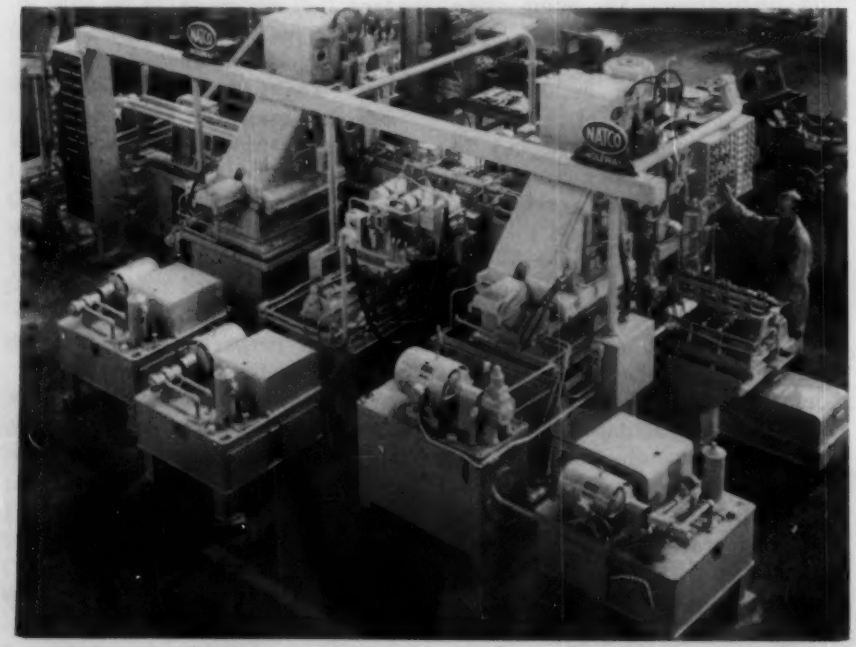
To eliminate sticking valve components that might require the baseball bat treatment to cause operation, Vickers' Industrial Hydraulics Div. chief engineer, Jim Robinson recommended keeping the systems clean. Filtering circuits were discussed, including a list of advantages for the automatic features of a by-pass filtering system.

User Preferences

To facilitate maintenance, users prefer tubing runs to be on the outside of the machine rather than concealed in the base. This represents a compromise for the machinery salesman who feels that on buying day the customer is more likely to prefer a sleeker looking job that he will curse on maintenance day.

Preference was also expressed for the use of a separate power unit for each head of a transfer machine, rather than operating several heads from one pump. Arrangements that involve a single tank, serving multiple pump and valve units, as opposed to systems of decentralized tanks and pumps were called OK if valves are marked with the identity of the heads that they control. Auxiliary clamping cylinders operating from a single pump manifold system are considered satisfactory.

Electrical interlock of complicated machine tool circuits using solenoids, relays limit switches and the like is presently more popular than hydraulic interlock. Chief advantage of hydraulic interlock listed was that in the event of trouble only hydraulic service is required, not both hydraulic and electric. A system for hydraulically synchronizing separate cylinders on a multiple drilling setup was discussed.



This Natco Holeway processing type machine for boring and drilling throttle bodies is an example of a hydraulically powered machine tool for auto parts.

Standardize

W. A. Hertel of Weatherhead gave data on the SAE straight thread fitting standard. J. E. Merkle of Ford told of his company's standard for hydraulic cylinders which includes mounting dimensions, envelope sizes, port threads, sealing devices, and shaft flats, but leaves internal construction to the manufacturers discretion, thus allowing freedom for technological advance. Need for interchangeable cylinders is now recognized. Standardization of other hydraulic components is next.

JIC standards were the constant reference of the discussers, but evidence of varying interpretations revealed possibilities for further clarification.

Developments

Discussions revealed that Vickers is working on machine tool hydraulic servosystems that use electronic control circuits programed by tape and punched cards. Also on the docket are combinations of hydraulics and Cypak controls, plus new straight hydraulic control panels and valves to extend the use of hydraulics to broader applications.

Conference Highlight

Guest afterdinner speaker was Nevin L. Bean of the Ford Motor Co. who presented a slide illustrated paper entitled, *Observations of Russian Automation and Production.* This presentation gave an automaker's eye view of Russian automation as personally observed on his Soviet tour. This revealed that the Russians have a fascination for automatic operations, but their products and shops show that compared to the American automakers they still have a long way to go.

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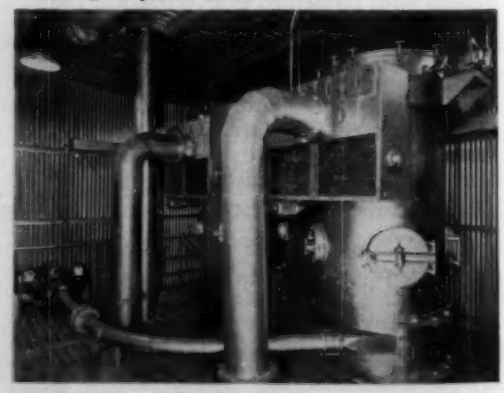

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Don't Ask For Miracles

A manufacturer had just concluded a lengthy and successful search for a specialist who could automate the production process for one of his high-volume items. The outlook looked rosy and the specialist builder knew the job would be easy based on previous operations of a similar nature. Again, however, came the cropper.

Before concluding an agreement, a whole series of items of identical character but ranging in size from small to very large was brought into the discussion. The machinery, it seemed, was to handle all the sizes without difficulty or much added expense. While none of the additional sizes enjoyed what could be termed high production, this seemed to make little impression. All sizes had to be handled. It was all or nothing.

This is just a generalization of the many requests for miracles being encountered today. Dollar advantages for one product are being passed up without second thought because all can't be included. Some serious study will reveal the basic error of such efforts.

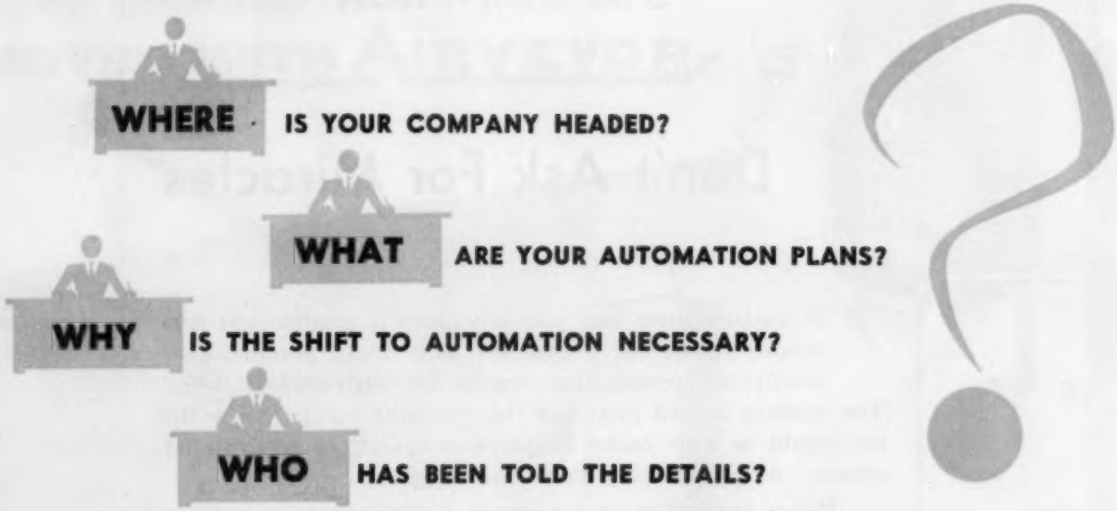
While a few automation installations have been designed to cope with multiple-product production, most features of such items are basically identical to permit reasonable handling. It is practical to standardize features across a line of products to permit economical processing in the same machines but to expect to handle a wide range of sizes where only form is similar is asking for the impossible.

Without adequate investigation, some are looking hopefully for Utopia—an automated line to start with molten metal and finish with a packaged product. It's not impossible, but once the market and the economics have been evaluated, no grounds may remain for pursuing the project further. It must be practical.

Automation that is practical and reasonable from the standpoints of design and production, offers great potential in dollar savings. But don't ask for miracles.

EDITOR

AUTOMATION


WHERE IS YOUR COMPANY HEADED?
WHAT ARE YOUR AUTOMATION PLANS?
WHY IS THE SHIFT TO AUTOMATION NECESSARY?
WHO HAS BEEN TOLD THE DETAILS?

MANAGEMENT— SELL AUTOMATION

By DONALD M. SWARTZ
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ONE OF THE DISQUIETING things about secrets is that sooner or later they aren't any more. And this sad truth seems to have been overlooked recently by some segments of industry as far as the projected use of automation is concerned. In fact, the gentlest suggestion that the automation plans of any particular industry be made public, unleashes a quiet ground swell of opinion that the suggestor should get his head fixed.

It's easy to trace the line of thinking which leads to the conclusion that to be mute is to be safe. It's also easy, although less so, to sympathize with those who profess to believe in muteness, since we have all been exposed to the same huddle of shivering and ill-formed myths about "Man, A Slave To The Machine and Other Obscenities", or "Down With The Wheel, The Sled Builder Has To Live". What isn't easy to see in this doctrine of voicelessness, is anything other than a short term and apparently expedient solution to what its proponents consider to be a problem. Not talking about a time bomb doesn't make it tick any less quickly. And unfortunately automation has been made to look like a time bomb to a lot of people, including some who should know better.

How many times have we heard management contradict the dire prophecies about the consequences of automation, gloom-ridden predictions full of phases

SELL AUTOMATION TO INDUSTRY

". . . I propose that our industry work openly to promote automation, to answer those who misrepresent it, and to explain its benefits patiently and ceaselessly to those who stand to gain the most from it—the American people. No other American enterprise is so deeply and at the same time so variously involved in automation as ours. Since the emphasis of automation is on electrical control we will have an increasingly important part to play . . ."—*Gwilym A. Price, president and chairman of the board, Westinghouse Electric Corp.*

Time and again the challenge has been hurled to defend the trend toward automation in industry. Silence can only be interpreted as default, secrecy as a clandestine method. The cloak is suggestive of the dagger.

like "armies of unemployed" and "miles and miles of workerless factories"? And how many times have we heard a rebuttal defending automation couched in terms as dramatic and emotionally charged as those used in attacking it? How often have the myths been called myths, loudly and publicly? Not nearly often enough. And why hasn't management taken a more vocal stand; set up a soapbox of its own? The only answer seems to be that it either believes the myths, heaven forbid, or thinks that everyone else does and has decided that since the battle is already lost, the wisest course is to lie low and keep quiet, and perhaps no one will notice. And so we appear to have another sacrifice to the current spirit of outspoken agreement; another victim of the delusion that controversy is a dirty word.

Of course, there are those who contend that the reason for maintaining a steadfast silence about the future use of automation is not so much what we might call discretion, for want of any but a much harsher word, as it is the desire to keep the competition off balance, to get the greatest possible advantage from being first. Assuming this to be the case, then, the lowering of voices and the closing of office doors when the subject is broached illustrates an amazing and really profound respect for the competition's hearing, and conjures up a picture of a vast network of intertwined ears joining competitor to competitor, too unnerving to long contemplate.

So we are driven back to our original conclusion that the real reason for keeping automation planning in a dark green bottle at the back of the shelf is the tacit acceptance of the attitude that the subject is just too loaded for public display; that the only way to introduce automation into a plant is under the cover of darkness because the children might become frightened and panicky.

But is the face of the future really so horrible to look at? We know, of course, that it isn't, and we know with equal certainty that the people who would be affected by it are not children and don't have to be treated as though they were.

But of even greater significance is the consideration that even if automation were the voracious ogre the myths say it is, and even if the people affected were the sort who had to be shielded from life by cotton-batting, the concealment of automation planning by pretending that it doesn't exist, until forced to admit that it has existed all along, is to follow a course which makes muddling through seem, by comparison, sheer tactical brilliance.

▸ Inherent Danger In Secrecy

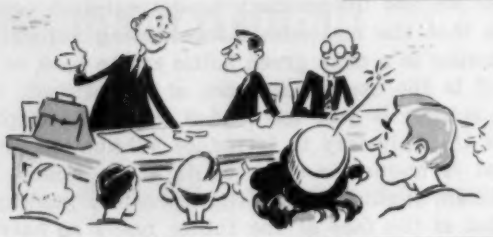
There are two fundamental reasons for this, neither of which may seem to have very much bearing at first glance. The first is that the normal never attracts attention, which is hardly news. Nor, really, is the corollary that the greater the degree of departure from normality, the more marked is the response to its observation. And it doesn't matter, as far as the intensity of the response is concerned, whether the change is for the better or not. The response to finding a diamond the size of an auk's egg is not noticeably more profound or durable than the response to losing it. The difference is in kind rather than in degree.

The second reason is that since the use of automation by a particular company must inevitably become a matter of public knowledge, attempts to forestall its exposure are about as practical and realistic as King Canute's seaside activities, and for the same reasons. Clocks don't stop because we refuse to look at them.

Given, then, the fact that a surprise is a surprise (which hardly rates as one itself) coupled with the inevitability of exposure, we soon find

SELL AUTOMATION TO WORKERS

". . . is this automation? You bet it is. The more automation that we can install, the more secure our jobs become. Is this principle new with Allen? Not at all. This is merely a continuation of our long standing policy of keeping our equipment up to date through increased mechanization. However, this is the first time that we are eliminating the heavy physical activity and the interruptions. This will have tremendous advantages for us here at Allen . . ."—*AlleNewsletter, The Allen Mfg. Co.*



SELL AUTOMATION TO STOCKHOLDERS

". . . through the consolidation of these companies, their respective abilities in engineering, manufacturing and marketing would be combined and applied to problems of automation in commerce and industry . . ."—*Directors of Sperry Rand Corp.*

that trying to keep automation planning a secret is like trying to hide a harp on a streetcar. The simile becomes more accurate if we add that there has also been a great deal of loose talk about a harp being stolen. Under such circumstances it is certainly far wiser to trundle the thing openly down the aisle than to throw a blanket over it and act as though it weren't there or as though it were some new kind of loom.

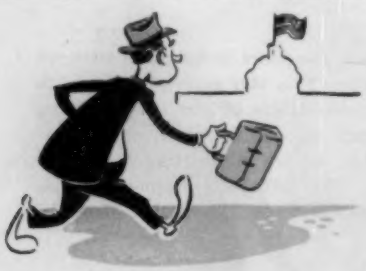
It is particularly wise if the harp *hasn't* been stolen, which corresponds to the situation with automation. Even with the bill of sale in our pocket, the effort to disguise or hide what we're about in an attempt to keep out of trouble or avoid controversy hardly lulls suspicion. In fact, it looks disturbingly like hypocrisy.

And so it looks when the inevitable finally occurs and the word is passed that automation has at last arrived. The good which can follow is ignored and the reaction is derived almost exclusively from the surprise, a reaction which is considerably increased by the feeling that one has been deceived. And here we have the real crux of the problem. While there is every defense against those who attack automation as an evil, as a destroyer of jobs, as a technological bogy, there is none against those who cry "Hypocrite!" at such a time. We can prove to a man that automation won't destroy him, but how can you prove to him that you didn't deceive him, when the months of silence just ended stand against you?

▶ Candor Minimizes Deviation

The conclusion would seem to be, then, that the most satisfactory course, or at any rate the least damaging one, is the one which minimizes the inescapable departure from normality, which in this case means departure from what has been, and hence minimizes the equally inescapable reaction. Certainly the shock at discovering that one has been deceived over a period of time in the immediate past—regardless of whether the deceit has been active or passive, a result of things done or things not done—is even greater than the shock of learning that one is to be replaced, to take the worst and most extreme case, at some time in the future. And since this is so, the most reasonable, sensible course is the one which is the most candid, the one which makes no secret of the fact that automation is a definite part of management planning and which points out to everyone concerned just what its inclusion means.

This conclusion ignores completely several other rather significant characteristics of the human animal which have a certain pertinence here. The first is that people, bless them, have a remarkable knack for forgiving and forgetting, particularly when the thing they're forgiving and forgetting has happened to somebody else. The second is that people are motivated not by what a thing is apart from themselves, but by what it is as far as they are concerned. Where such concern involves only the use of the head, there is generally some agreement as to what the thing really is. But where such concern involves the viscera, or what some sentimentalists euphemistically refer to as the heart, cerebral considerations have a nasty habit of going to visit an old aunt somewhere, returning only when the plaster has stopped falling. During the interval between, the pit of the stomach reigns supreme, and the qualities and characteristics of objects and events are reflections of the way each person happens to feel about them at the time, with a cavalier disregard for anything which has weight enough during times of reason to alter that view.



SELL AUTOMATION TO GOVERNMENT

". . . I would like to talk a little bit about automation because I think I would like to try to put it in the concept that I see it, which doesn't have any of these fears, any of these future unknowns. Based on what we have researched in the Labor Department, we see in the next ten years an accleration of worker productivity brought about by increased technological change and that is what automation is . . ."—*James P. Mitchell, Secretary of Labor.*

SELL AUTOMATION TO THE PUBLIC

". . . it is important that the public have an informed picture of the effects of automation and technological change on our national life because everyone has a personal stake in this progress. Frequently one reads statements which give lip service to the obvious benefits of automation, but go on to exaggerate the problems of adjustment until they make automation appear to be a public menace. Automation is not a menacing development. It is in fact a concept which has already raised the nation's standard of living and has had a stimulating and stabilizing effect on the economy. It will continue to have this welcome effect in the future . . ." *—Ralph J. Cordiner, president, General Electric Co.*

The significance of these two human faculties, or frailties if one wants to take sides, to the public relations problem at hand is appreciable. The fact that during periods of stress, we impose ourselves on things we observe much more strongly than we do during periods of comparative calm means that no matter how much good there may be in an event or situation or object, we can mark it down as the double distilled essence of evil if it so strikes us at a time of stress. Thus no matter how much good automation has, no matter how rich its promise and rewarding its fruits, all of its virtues can be forgotten if its presentation is badly handled. And certainly sneaking it in the back door or allowing its intended use to be discovered by accident fall somewhat short of any definition of effective presentation. It becomes instead a sort of Trojan Horse in reverse. The conclusion to be drawn here seems to be another vote for candor, since with candor the reaction can be steered towards the cerebral and away from the visceral, and hence towards a clear recognition of the inherent good in automation rather than towards its emotional veiling. The success of the opposite approach, the deliberate appeal to the emotions in an attempt to paint in bile a portrait of automation as a hydra-headed, job-devouring monster, is now a matter of history, and clearly points up both the need for countermeasures and the importance of effective presentation.

▸ Subjective Public Relations Problem

The other human tendency we mentioned, that of quickly burying other people's misfortunes, might seem at first to be an argument against rather than for candor, since it implies that in spite of the strong feelings aroused in those directly concerned with the application of automation, the remainder of the population is really a loose collection of disinterested and only temporarily disenchanted spectators, whose fleeting reactions are of no lasting concern. In reality, however, the fact that the intention to use automation or its actual application is soon forgotten if not blandly ignored adds further strength to the argument that frankness and openness are not to be feared. And even if the public reaction were unfavorable, anything which minimizes the severity of that reaction is desirable since it tends to speed forgetfulness, or, more accurately, tends to shorten the period of continuing awareness; certainly the positive avoidance of deception would so serve.

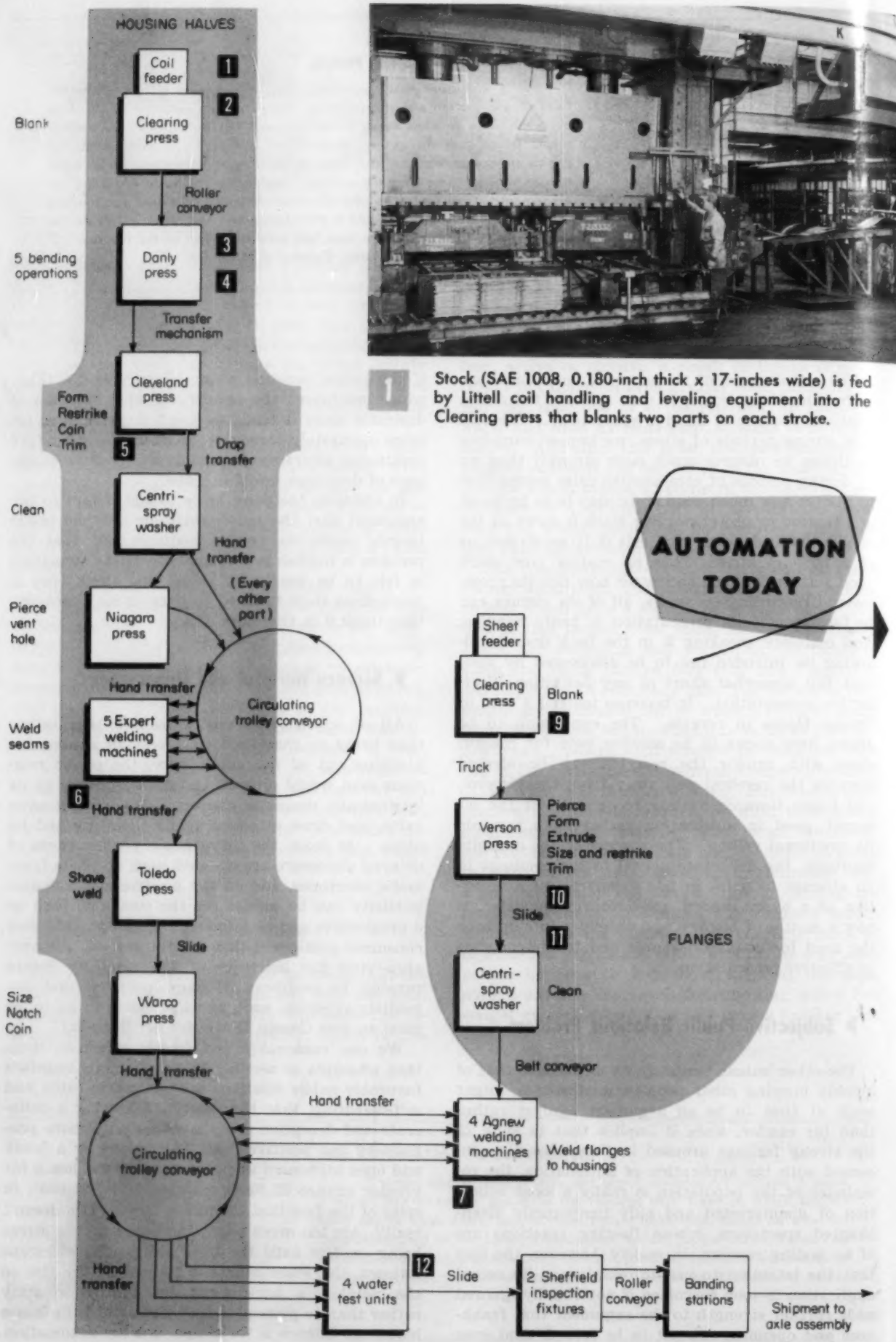
In addition, the point helps to add weight to the argument that the public relations problem exists largely inside the public relations man, that the problem is ticklish in the same way that automation is felt to be deadly by those who think that it jeopardizes their futures. To paraphrase Descartes, they think it is, therefore it is.

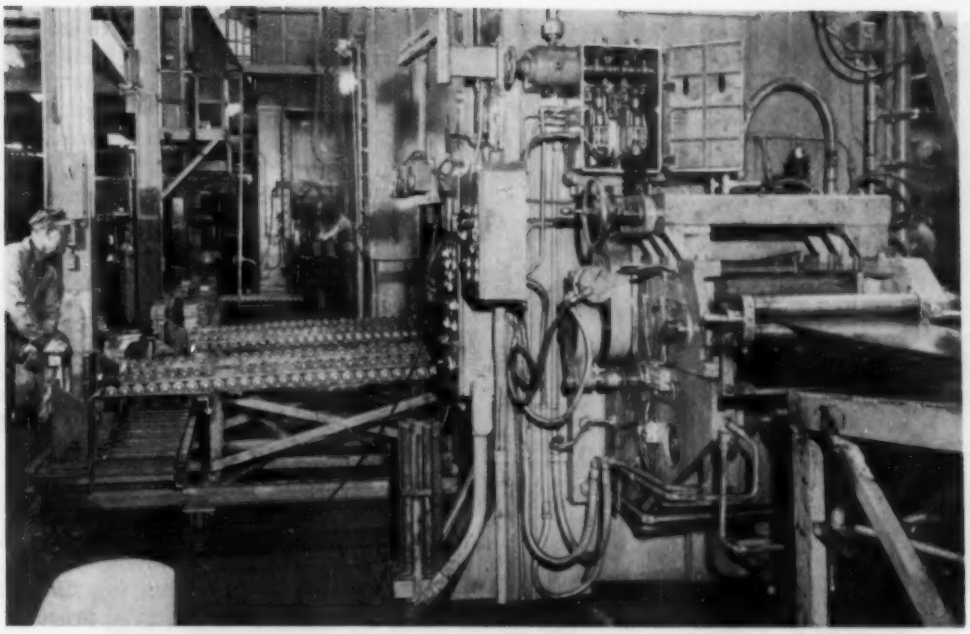
▸ Secrecy Harmful and Unnecessary

All of which leads one to believe that rather than being so concerned with keeping automation planning out of the public view, the public relations man would do well to take advantage of its intrinsically dramatic character, its built-in news value, and draw attention to his company and its plans. At least the unfortunate consequences of delayed disclosure are avoided, with all of its traumatic overtones, and on the positive side valuable publicity can be gained for the company, both as a progressive and as a thoughtful entity. The vast consumer public will then briefly and not unfavorably view the activities of the company before turning to problems of more personal and immediate pressure, such as what movie to go to, or what to give Cousin Hattie for her birthday.

We can reasonably and finally conclude, then, that attempts at secrecy in an effort to maintain favorable public relations are ultimately futile and self-defeating, that the reaction following a deliberate and deceptive delay is necessarily more pronounced and positive than that caused by a frank and open statement of plan or policy and has a far greater chance of being unfavorable, and that, in spite of the fact that the public in the main doesn't really care too much about the house up the street being on fire until the wind shifts and threatens its own, the wiser course is to confine the fire to the neighbor's back steps by acting promptly rather than to pretend it isn't there until the house blows up. Silence is for clams, not for automation.

1 Stock (SAE 1008, 0.180-inch thick x 17-inches wide) is fed by Littell coil handling and leveling equipment into the Clearing press that blanks two parts on each stroke.





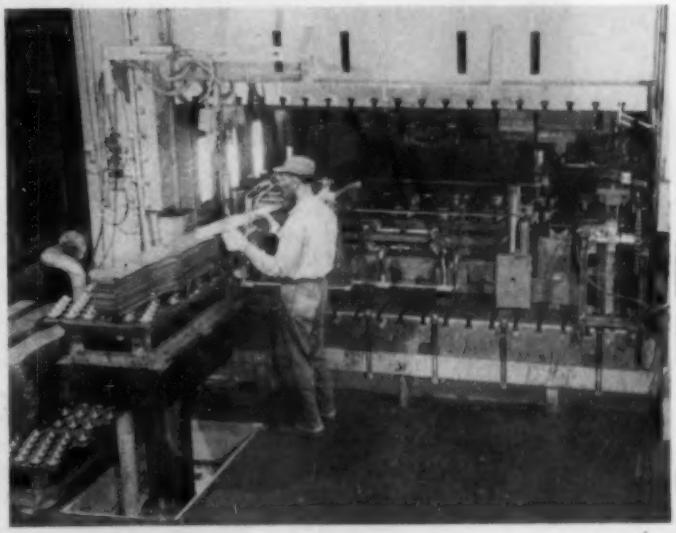
2 Parts are automatically ejected to gravity wheel conveyors that drop them onto stacks on a roller conveyor. Stacks are periodically released to roll on to the next press.

STAMPING AXLE HOUSINGS

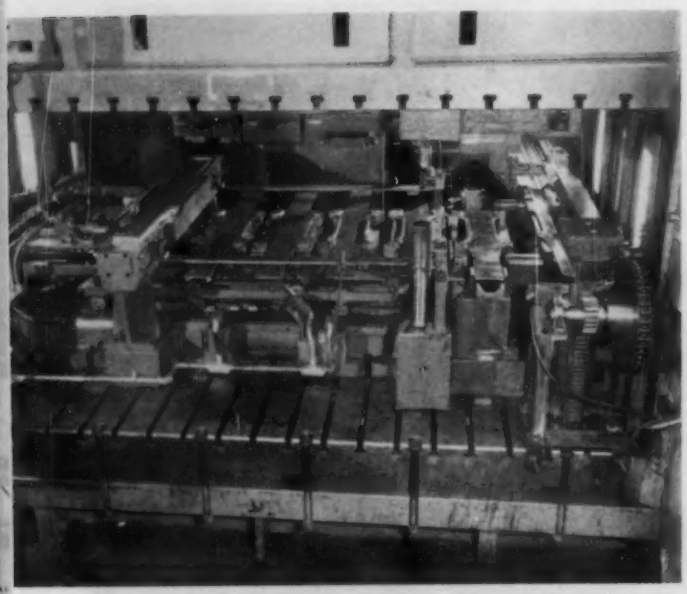
PRODUCTION PROCESSES, that make the desired product from stampings which are welded together, often show savings in manufacturing costs as compared to alternative methods of producing the equivalent product. The automobile industry's changeover from the use of castings to stampings for rear axle housings is due in part to the desire to achieve production savings and in part to the product designers wish to carry less unsprung weight on the wheels. Successful accomplishment of both goals can give the buyer a better ride for less money, both desirable features in a highly competitive market.

To make rear axle housings for their 1956 cars the Buick Motor Division of General Motors Corp. installed a completely new production line that embodies the latest thinking in welded sheetmetal processing. The project not only involved new tooling and machinery but included raising the roof in a factory bay and installing an overhead air conditioned balcony to house the generators, regulators and related equipment for the automatic welders.

The assembly completed on this line consists of four detail parts: One upper and one lower half-housing and two flanges. All parts are of SAE 1008 steel; the housing halves are made from 0.180-inch thick stock and the flanges from 0.375-inch thick stock. The lighter material is fed to the blanking press from coils and the thicker stock is received in 100 pound sheets.



3 Ball transfer plates facilitate movement of stacks onto hydraulically elevated table, permitting operator to feed smaller stacks of blanks into the loading station of the Danly press.

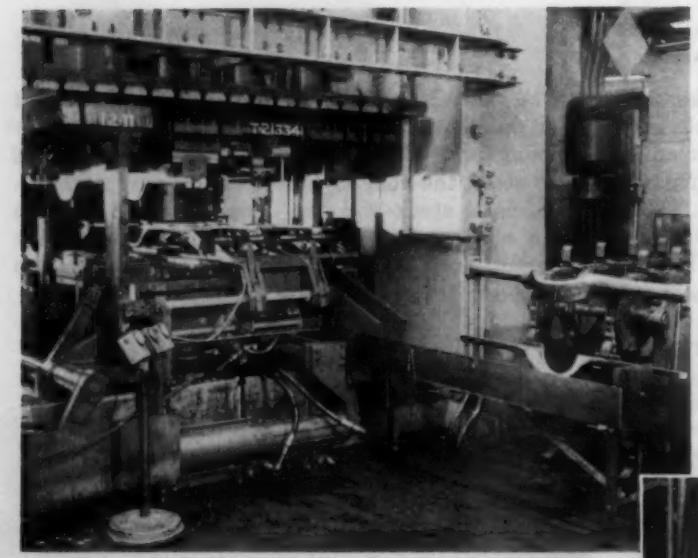


4 Closeup of transfer mechanism of the Danly press shows the five die stations that progressively bend over the center flanges to double metal thickness and put a vee bend in the entire length of the blank. Parts are fed from the stack on the left, to successive die sets and out at the right to a transfer mechanism behind this press which automatically loads the next press.

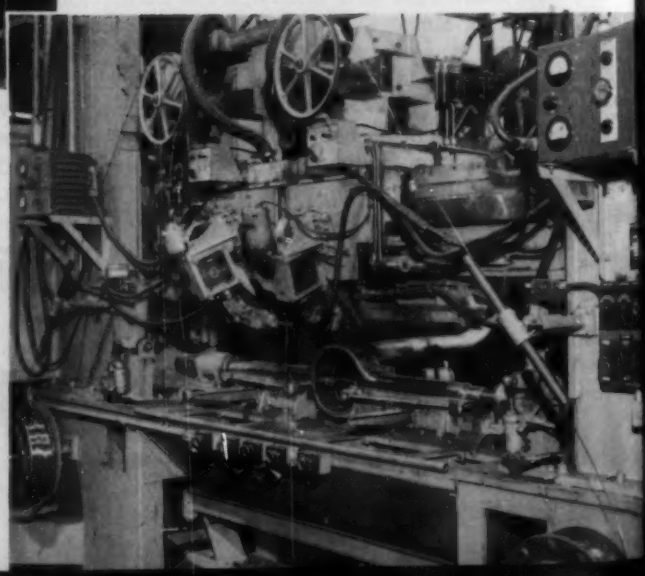
Housing halves are essentially identical parts and are made on one branch of the production line—another branch makes the flanges. These branches come together to form the assembly welding line, which also includes press, hydrotest, and inspection operations. Two circulating trolley conveyor systems provide for in-process storage and handling between operations where more than one identical machine setup is required.

Keynotes of the line are: The use of parts handling equipment to save the workers from the back-breaking task of lifting large stampings, the transfer mechanisms that move parts between successive die sets within a given press, and the automatic cycling features of the welding machines which include automatic operation of the fixtures. Safety interlocks between the controls of the presses that are linked by transfer mechanisms provide protection for personnel and equipment in the event of a misoperation.

The accompanying diagram and photos show a modern production process that is far from the "No-Hands" vision of the wild-eyed dreamers, yet is a far cry from the old time press room and production line of 20 years ago that turned out more injuries, more backaches, and less production. This line provides an example of the present state of the art of automated production.



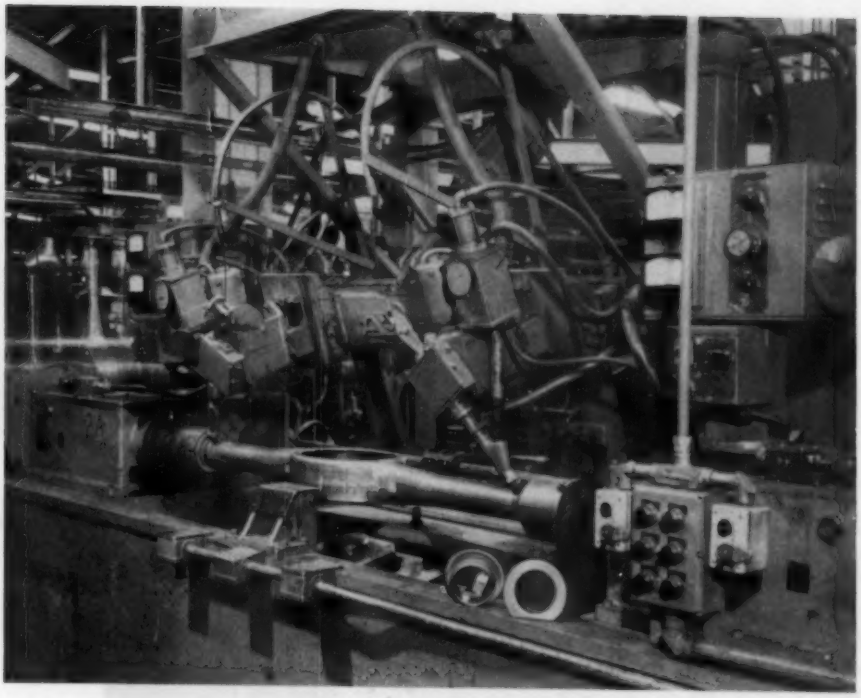
5 Next press in the production line forms the housing halves into the banjo shape, restrikes, coins and trims them in a four station setup that is equipped with transfer devices. This photo shows the back of the Cleveland press where parts are drop delivered into position to be picked up by conveyor hooks on the entry end of the Centri-Spray washer.

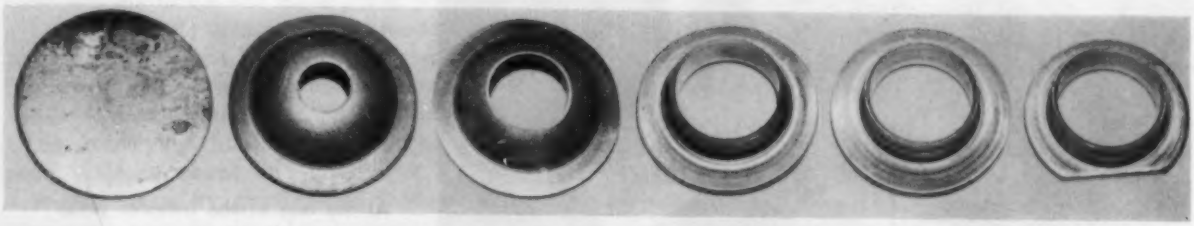


6 After being washed and dried, half the parts get a vent hole punched out on a Niagara press and join the other half for a ride on a circulating trolley conveyor system. The conveyor supplies parts to each of the five Expert automatic welding machines. This picture is a closeup of the work station and welding head carriages of one of these machines that submerged-arc welds four seams to join the two halves of the housing. Parts are hand loaded and unloaded, but automatically clamped and welded. Upon completion of the welding cycle the operator places the finished part back on the circulating conveyor.

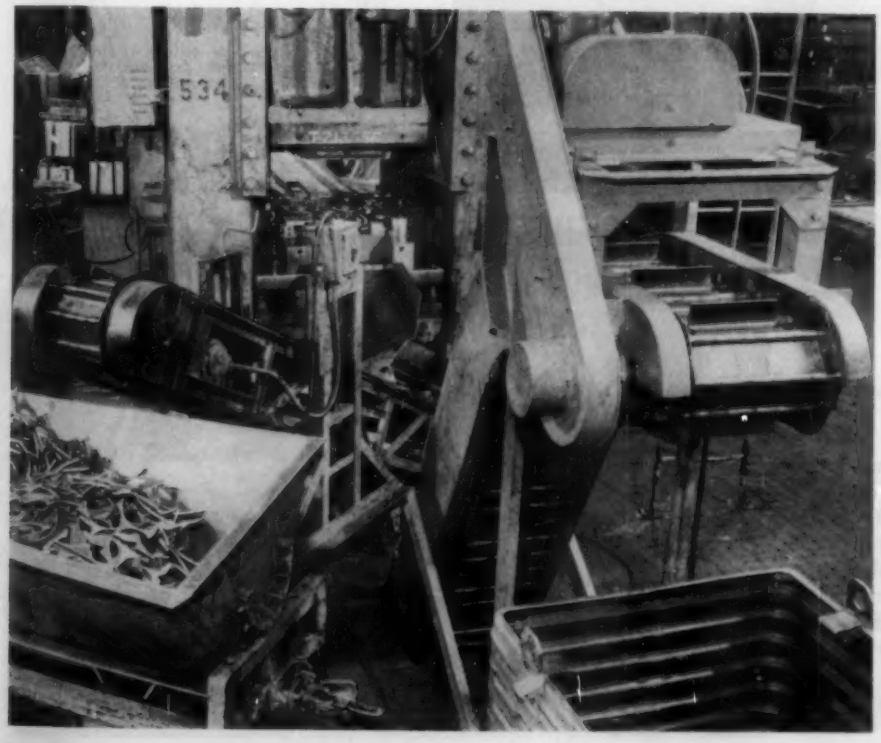
7

Welded housings are removed from the circulating conveyor by the operator of a Toledo press where the weld material is shaved off the ends of the housing to enable the flanges to be assembled. The next operation, on a Warco press, coins notches and sizes the material around the banjo opening. Parts are placed on another circulating conveyor that supplies each of the four Agnew welding machines that positions the flanges and welds them by rotating the whole assembly under the welding heads as shown here.





8 Flanges welded to the ends of the housing are made from 0.375-inch thick SAE 1008 in six steps.



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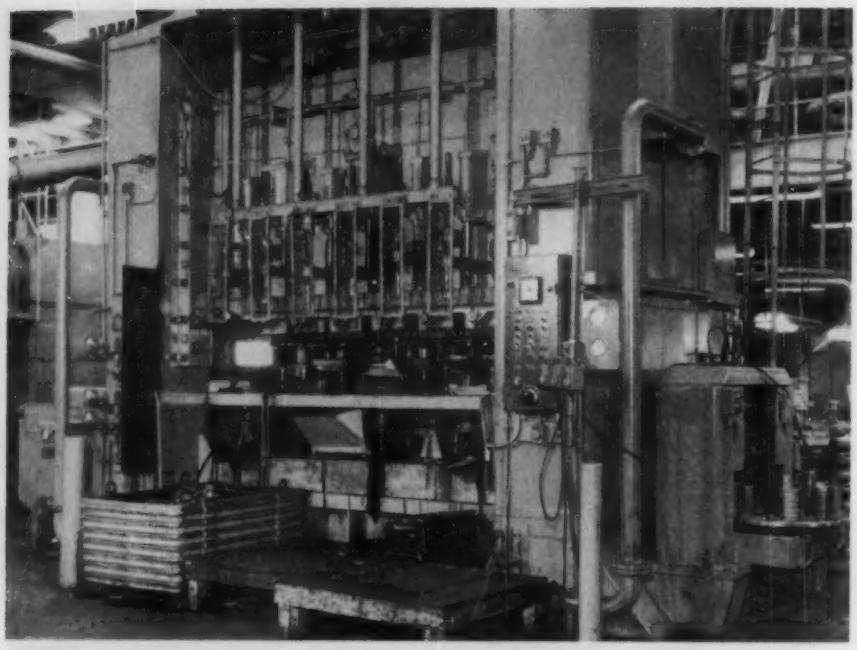
Blanking operation for the flanges is performed on a Clearing press. Three blanks are produced from each stroke. Scrap is chopped up and conveyed to the hopper shown at the left. Blanks are conveyed into tub at right for trucking to the next operation.



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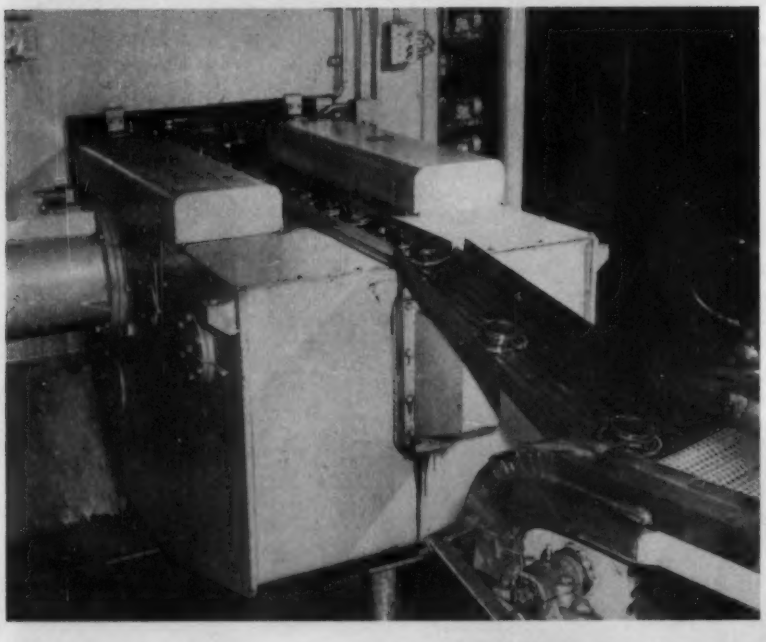
Remaining five operations on the flange are accomplished on this Verson transfer feed press. Stacks of blanks are loaded onto the feeder at the right where each blank is picked up and sent on its way through the press. After each stroke, sets of transfer fingers move into the open die sets and move each part to the next station.



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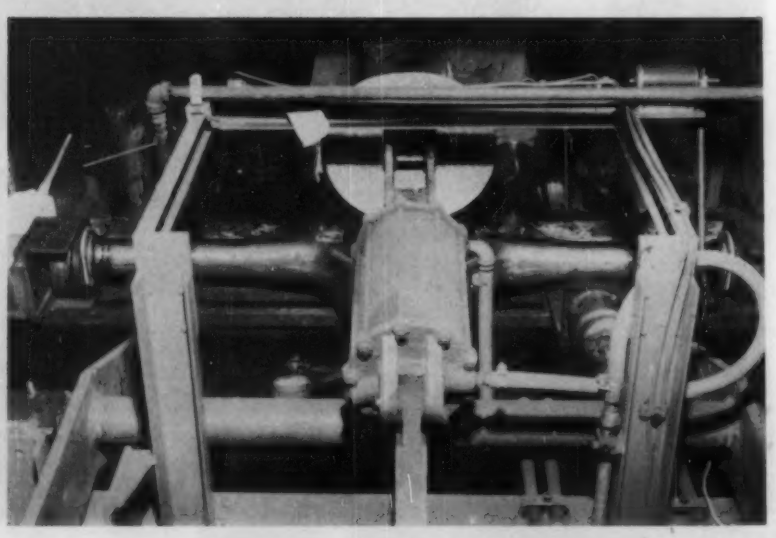
At the end of the transfer press the parts slide to the entry conveyor of a Centri-Spray washer where they are cleaned in preparation for welding.



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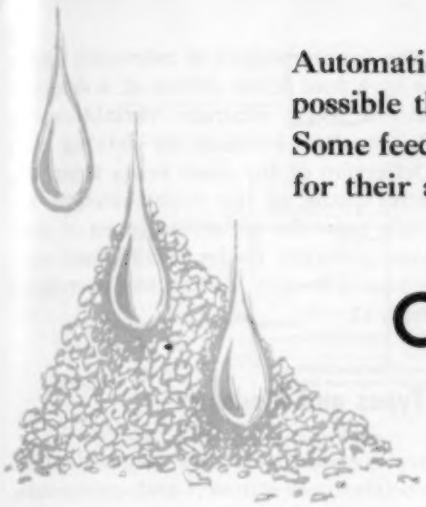
Finished Buick axle housing assemblies are hydrotested for leaks. The cavity is filled with air at 6 psi and the sealing fixture is cycled underwater so the operator can check for bubbles. After this operation the assemblies are 100 per cent inspected for dimensional acceptance at one of two identical Sheffield gaging fixtures, and banded with steel straps for shipment to the axle assembly line.



Automatically regulated feeders for dry and liquid materials make possible the continuous, controlled processing of such materials. Some feeder types, systems for regulating their output, and points for their application are discussed in this article.

CONTROLLED FEEDING

FOR LIQUID AND DRY MATERIALS

By P. A. COFFMAN, Jr.
Vice President and Chief Engineer
Omega Machine Co.
Providence, R. I.

CONTINUOUS MEASURING of liquid and dry materials has made great progress in the past twenty years. Many modern industrial processes would not be feasible or possible without feeders which can automatically record or regulate the flow of material from a bin or storage chamber, along conveying lines, or into processing equipment. Measurement and control of materials on a weight basis by gravimetric feeders is a most important area in the development of automatic processing systems.

There are two basic types of gravimetric feeders available from several manufacturers: the belt gravimetric for dry materials only, and the loss-in-weight gravimetric for both dry and liquid materials. Every gravimetric feeder, no matter what type, must have three basic elements in order to serve its function: the weight sensing element or scale, the feeding mechanism or valve, and the controller. The scale and the feeding mechanism are generally similar no matter who the manufacturer. They are designed for simplicity, ease of manufacture, and durability. It is in the method and complexity of control that feeders vary to a great degree. The controller determines the regulating characteristics of the feeder, and the ability of the control elements to do the work required, properly and accurately, determines the usefulness of the feeding unit.

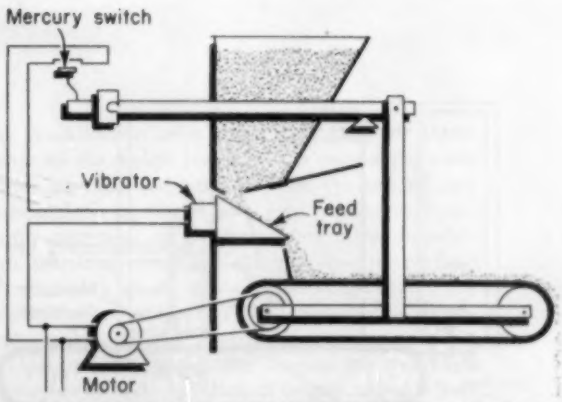
Based on a paper presented at conferences of the Instrument Society of America, September 1955 in Los Angeles, Calif. and January 1956 in Boston, Mass.

Gravimetric Feeder Types

Belt Feeders: Principle of operation of the belt gravimetric feeder is to control in some manner the amount of material passing on a belt over a weigh span or weighing device. In some cases, the entire endless belt and its suspension arrangement may be included in the controlled weight; in

BELT GRAVIMETRIC FEEDERS

Fig. 1—On-off control is the basic type of control, but is quite limited in the jobs it is capable of performing. The weigh belt is driven by a constant-speed motor. Rate of feed can be set only by positioning the counterweight on the scale beam. Deviation of the scale beam from its set point operates a mercury switch—starting or stopping the operation of a vibrator on the feed tray. In such regulation, there is no proportional control, as the vibration is constant. An increase in the deflection of the scale beam cannot make the feeding mechanism respond at a greater rate. A feeder of this type can be satisfactorily used to feed materials maintaining a uniform bulk density, but certainly should not be recommended where material characteristics are liable to undergo changes of any magnitude.



others, a section of the belt suspended from a scale system serves the same purpose. Weight, other than that of the material being fed, is compensated for by additional counterbalancing weights in the scale system of the feeder, or in the counterweight on the scale beam. The scale beam is calibrated and marked, and positioning of the counterweight establishes the desired belt load. The deflection or degree of deflection of the scale beam from its horizontal position, as material passes over the belt, initiates controller action. Illustrations of different types and modes of control for belt feeders are shown in *Figs.* 1 through 6.

Loss-in-Weight Feeders: Unlike the belt gravimetric feeder, the loss-in-weight feeder is capable of feeding and controlling both liquids and solids. It is generally more accurate than the belt gravimetric feeder and will always give a correct record of the material which has been fed. The weight of material in the hopper or tank is transmitted through a scale lever system to the scale beam, and is counterbalanced by a counterweight on the scale beam. The counterweight is retracted along the scale beam by a lead screw driven at a selected rate of speed. A very accurate variable-speed transmission is usually provided for driving this lead screw. Deflection of the scale beam from the horizontal control point as the counterweight retracts is the basic point for all of the types of control for the loss-in-weight feeder. Different control means for loss-in-weight feeders are portrayed in *Figs.* 7 through 11.

▶ Control Types and Modes

Feeder controls covered in this paper include mechanical, electrical, electronic, and pneumatic types. There is very little choice among the types of control as far as acceptability and utility for specific applications are concerned. Each has its proper place, and each may be complex or simple depending on the requirements of the application. The type names in themselves are in the most part

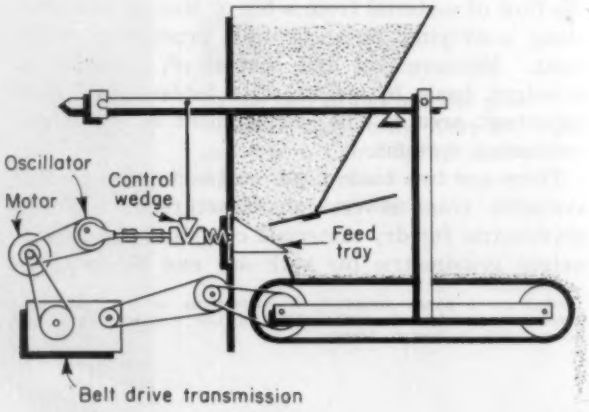


Fig. 2—In this mechanical proportional control system, the desired belt load is set on the scale beam with a counterweight. The amplitude of vibration of the feed tray is then determined by the vertical position of the scale beam. Lowering of the scale beam, due to belt loading less than the set amount, will drop the wedge between the jaws of the oscillator and feed tray, causing the tray to vibrate and feed material. Further lowering of the wedge increases the vibration amplitude of the feed tray resulting in a greater volume of feed. Rate of feed is therefore proportional to the amount of scale beam deflection. The control point may be adjusted by manual adjustment of the wedges and jaws.

Proportional mechanical controllers have many uses in industrial applications. The accuracy of the feeders is good, and simplicity of the control makes it easy to operate and dependable in operation. It is by far the simplest type of proportional controller.

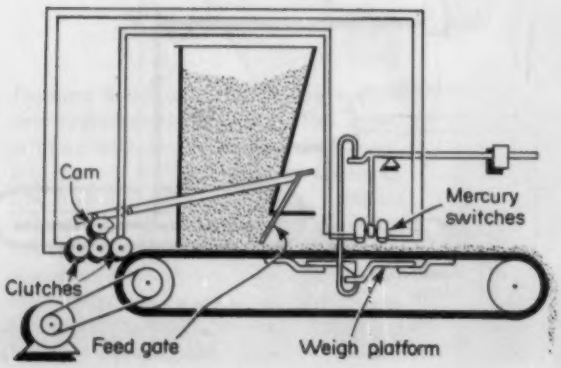


Fig. 3—Application of electric single-speed floating control to a belt feeder. The belt is driven at a constant speed, and feed rate is changed by altering the position of the feed gate which determines loading of the belt. Change in the weight of material being fed will cause one of two mercury switches to actuate its associated clutch and move the feed gate in the desired direction.

This type of feeder is limited in its scope because the rate of response to an alteration in belt load remains constant. A large error does not initiate any more rapid response in the feed rate than a small one. There is a possibility that if product characteristics should vary a great deal, the resulting over or underfeed will amount to more than is desired.

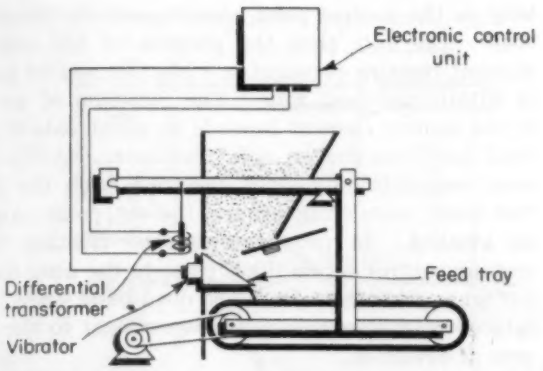


Fig. 4—The differential transformer in this electronic proportional controller transmits a signal indicating beam position to the electronic control unit. This unit sends a signal to the vibrator which is proportional to scale beam position. The amplitude of vibration of the feed tray is thus proportional to scale beam deflection. This is a more intricate type of proportional control. It has been successfully used, but is difficult and expensive to apply to many industrial processes because of explosionproof construction requirements.

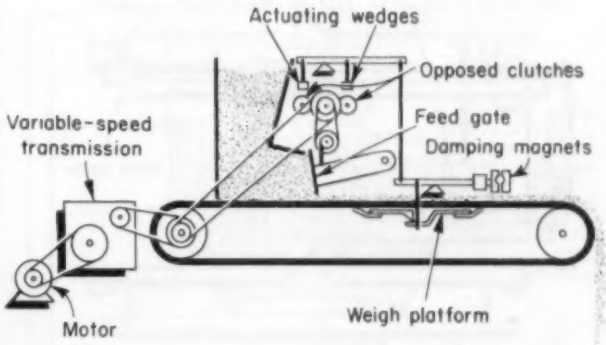
self-explanatory, so there is little need of an extended discussion.

Mode of control is very important because the proper design should be used to do the task required. Mode is the heart of control and determines the complexity of the device. Modes of feeder control discussed here are: two position (on-off), proportional, proportional plus reset, and floating (single-speed and proportional-speed).

A two position on-off controller is sufficient to do a simple control job, but should never be chosen where a complex feeding situation is likely to arise. On-off control is just what the term implies. When material flow exceeds a preset value the controller turns the feeder off; and, when the material flow falls below a preset value, the controller turns the feeder on. The flow of material is thus intermittent.

Proportional controllers do away with intermittent operation, and provide continuously adjustable feed rates. The feeding mechanism or valve operates to maintain the desired feed rate (set point). It selects a definite and different condition for the final control element for every material change within the working range. Proportional action may be adjusted by manual adjust-

Fig. 5—Mechanical system for proportional-speed floating control of a belt feeder. The desired belt load is set manually on the scale beam, and belt speed on the variable-speed transmission. The mechanical controller sends out a rotary signal to position the feed gate in relation to the actual load on the weigh span. While the belt load remains at the predetermined amount, the gate remains stationary. Any change in belt load will allow one or the other of the wedges to drop, engage a cam which actuates the proper clutch, and initiate a response movement of the feed gate. Rate of response is regulated by the length of descent of the wedge. The amount of response is dependent on the length of time the cam and wedge are in contact. The control band is regulated by adjustment of the wedges, and by adjustment of damping magnets, one of which is attached to the end of the scale beam, the other to a stationary support. The damping magnets actually are a sensitivity adjustment to eliminate excessive hunting. The



closer they are, the more stable the control will be. This method of adjusting control sensitivity provides maximum scale sensitivity at the null balance control point, regardless of the sensitivity adjustment required for a specific feeding problem.

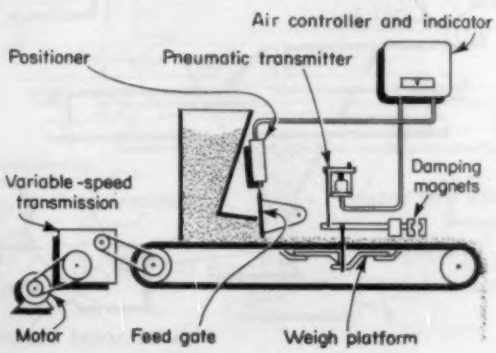


Fig. 6—Addition of a pneumatic position transmitter to the weigh beam and a pneumatic positioner on the feed gate permits the use of any standard proportional plus reset receiving pneumatic controller on a belt feeder. This installation provides a simple straightforward method of obtaining reset action where desired. The adjustment of the modes of control are simply and easily made in the air controller.

This type of application is used for processes where sustained material changes are encountered, and prolonged deviation from the set point or cycling control is not desirable.

ment of the width of the control band. The control band is the amount of deviation of the control point from the set point necessary to cause the controller to operate the control element over its entire range. In the case of gravimetric feeders the set point may be established by adjusting the counterweight on a scale beam. The control point deviation from the set point is the amount of deflection of the scale beam from its horizontal position.

Proportional plus reset controllers eliminate sustained deviation from the set point which can exist with the proportional controller. When a feeder leaves its set point, the reset response immediately goes into action and continues to adjust the control element until the control point is back to the set point. This refinement allows the feeder to operate more efficiently and accurately by compensating for any changes in material characteristics.

A single-speed floating controller moves the control element continuously at a constant speed as long as the control point remains outside the dead zone. The only time the position of the control element remains constant is when the control point is within the dead zone. The direction of action of the control element depends on which side of the dead band the control point contacts. As the element responds only after deviation from the control band, wandering around the set point cannot be avoided. In proportional-speed floating control, no control action takes place in the dead band, but when deviations from the dead band occur, the rate of control response is proportional to the degree of deviation.

The development of the several types and modes of controllers has been the result of a constant interchange of ideas and needs between manufacturers and users. Controllers are the result of a problem, anticipation of a problem, or the desire to improve a competitive situation. All controllers have their proper place. The system designer or engineer must have the ingenuity, imagination, and foresight to apply them properly.

LOSS-IN-WEIGHT FEEDERS

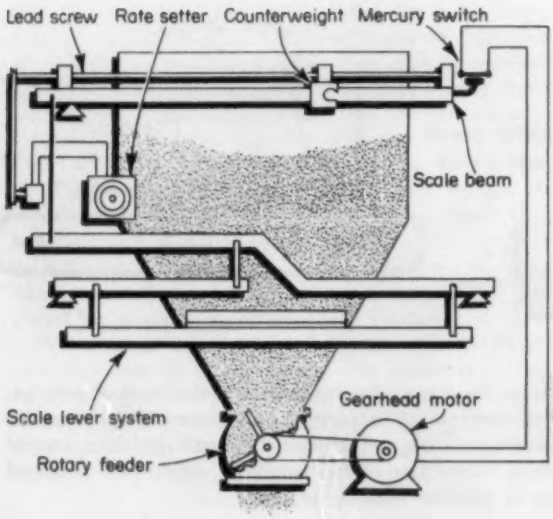


Fig. 7—On-off controller often used in conjunction with a rotary type feeding mechanism. The counterweight is steadily moved along the scale beam by the rate setting unit. As the scale beam deflects upward, it actuates a mercury switch which in turn starts a constant-speed motor. This motor drives the rotary feeding mechanism. The motor is geared to operate the rotary mechanism at a higher capacity rate than the specified rate of the feeder installation so the operation is a constant start and stop of the drive motor and rotary feeding mechanism.

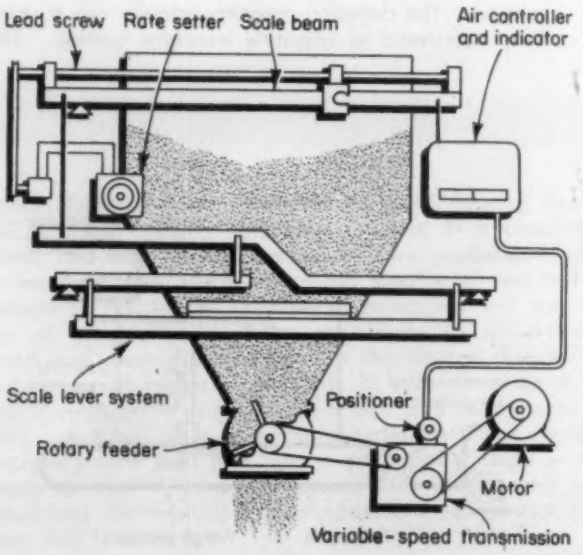


Fig. 8—A proportional plus reset pneumatic control system. The scale beam is mechanically linked to the pneumatic controller. This eliminates the need for the pneumatic position transmitter used on the beam in *Fig. 6*. The pneumatic controller is supplied with the proportional plus reset control mode. The controller air output goes to a diaphragm motor and positioner which position the cams within the transmission, and therefore adjust the speed of the rotary output. Thus, the flow through the rotary feeder can be adjusted to hold the set and control point together.

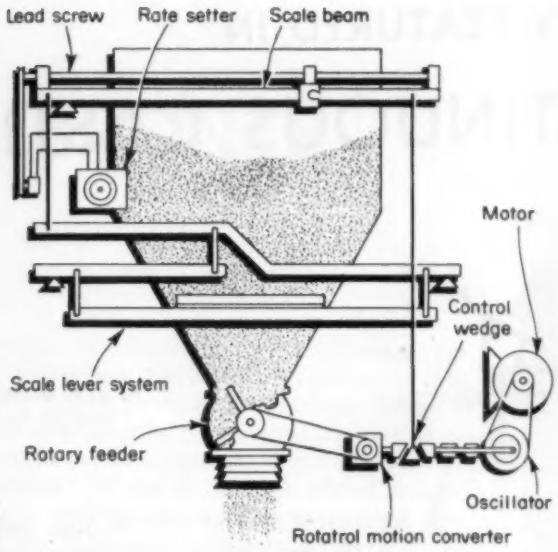


Fig. 9—Similar type of mechanical proportional control applied with a rotary feeding device. Among the applications of such feeding devices are their use where the material being fed has a tendency to flood. In this system the depth of penetration of the wedge between the jaws of the oscillator and the Rotatrol determines the rotary velocity of the feeding mechanism. The oscillator imparts to the Rotatrol a linear type of motion which is converted into a pulsing rotary output. The speed of this output determines the volume of feed. The further the scale beam deviates from its balance position, the more rapid will be the action of the feeding mechanism in the effort to return the feeder to its control point. The control action is therefore proportional to the amount of deviation of the feeder from its control point.

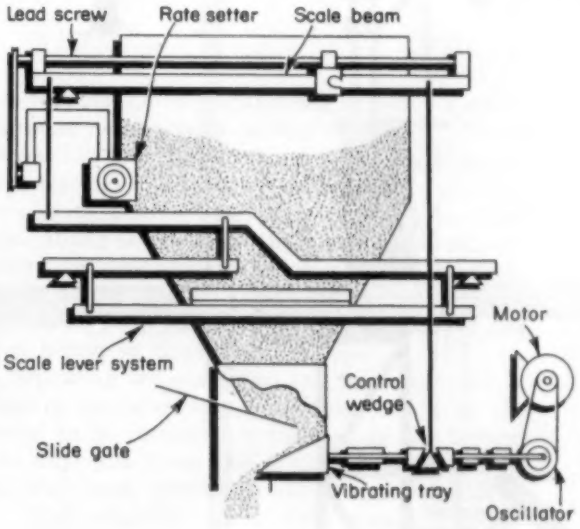


Fig. 10—Illustration of a mechanical proportional controller for a loss-in-weight feeder. The motor and oscillator operate at a constant speed but the amplitude of the tray vibrations is proportional to the amount of scale beam deflection. The depth of wedge penetration between the jaws attached to the oscillator and the vibrating tray determines the amplitude of vibration imparted to the tray and necessarily the amount of material being fed.

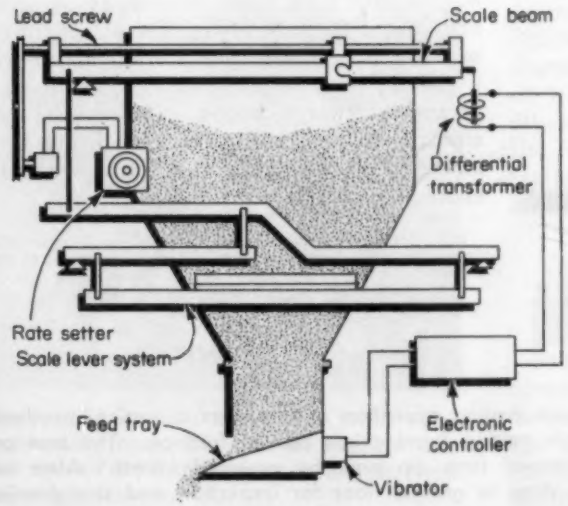
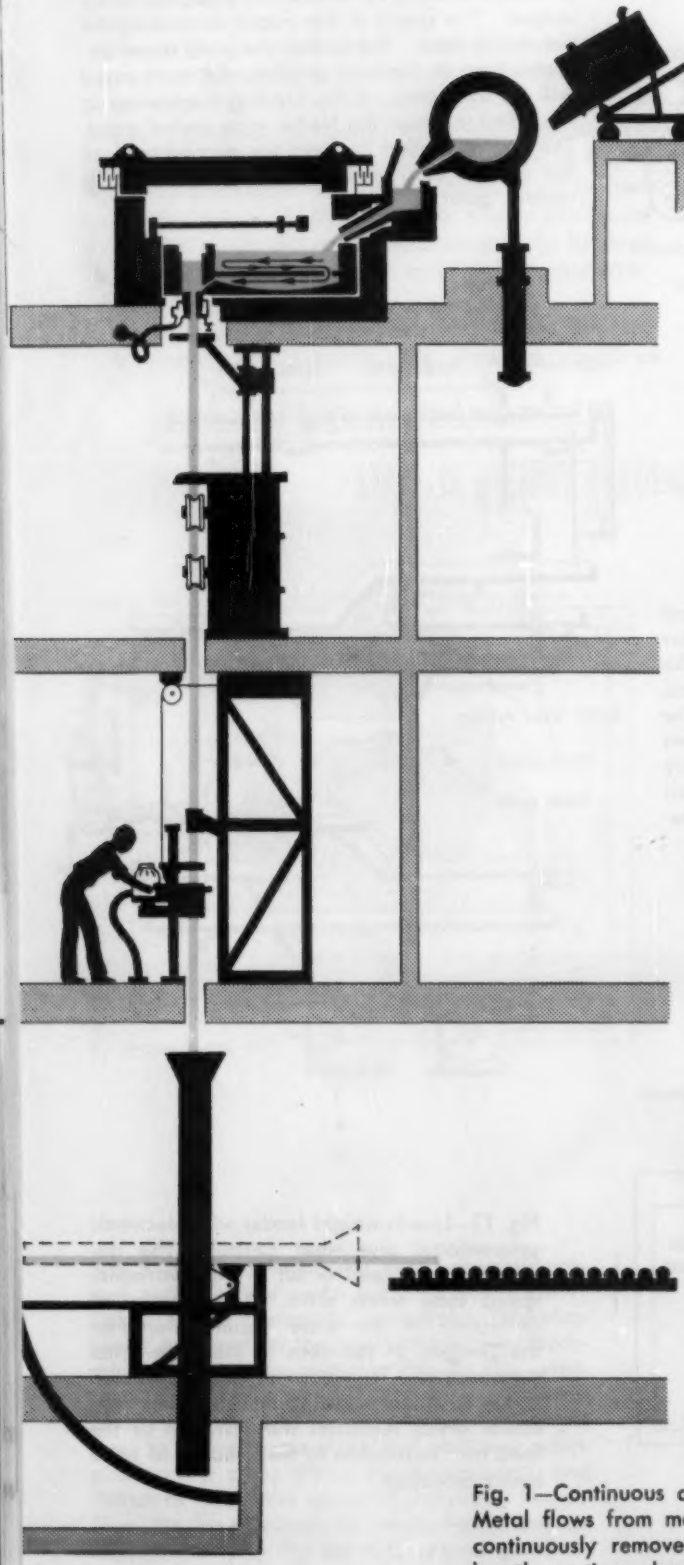


Fig. 11—Loss-in-weight feeder with electronic proportional plus reset control. The desired rate of feed is set on the variable-speed lead screw drive. The amount of deflection of the scale beam determines the position of the core in the differential transformer. This position is represented by an electrical signal to the electronic controller which regulates the vibration of the feed tray in relation to the amount of scale beam deviation.

PRODUCTION FLEXIBILITY FEATURED IN

CONTINUOUS CASTING



By J. B. MOHLER
Consulting Engineer

REGARDLESS of how we may define automation, the concept embraces a goal common to all manufacturing plants—the production of more pieces or more pounds per dollar of cost. In the foundry field, continuous casting is a proved method of production in achieving this goal. Continuous casting is not, however, a new technique.

Since 1937, American Smelting & Refining Co. has continuously cast copper billets. Based on experience gained in their copper billet plant, nine years ago the company perfected a procedure for the continuous casting of bronze in bar, rod, and shaped forms, *Fig.* 1. Today ASARCO can offer manufacturers a variety of bronze alloys ranging in diameter from 7/16 to 9 inches, and in a wide variety of solid and hollow shapes, *Fig.* 2. Increased demand for these bronze products reflects the growth of the machine tool and machinery industries—and their need for bearings and bushings. Continuous casting in the closely controlled, patented ASARCO process results not only in increased quantity of output, but also in bronze castings with superior fatigue, impact strength, tensile strength, yield and hardness characteristics.

Furnace Operation

In operation, the continuous production process begins with fork truck movement of scrap metal and ingots from receiving areas into storage. The material is removed from storage as needed, and in a charge preparation area, processed and placed in special charge boxes. The special boxes are elevated to a fourth story level which houses the melting furnaces—Detroit Electric Arc furnaces operating on an automatic cycle.

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Fig. 1—Continuous casting operation is set up as a vertical production line. Metal flows from melting furnace into casting furnace. The cast product is continuously removed from die area by powered rollers. After sawing to length, castings drop to ground floor for inspection and straightening.

OF BRONZE

Value of raw material stock to the metalworking industry is increased to the extent that it can be used in the as-received condition. But eliminating problems for the user creates problems for the producer that only versatility of production equipment can solve. Bronze alloy rod and tube products are no exception—and continuous casting is the successful production solution.

Power input is initiated with the individual furnace shell stationary, but after a set period of time, the furnace begins to rock. The rocking action of the furnace gradually increases until the shell is describing an arc of 250 degrees—a necessary action to insure proper mixing of the high leaded bronzes. During this melting process, as the carbon electrodes of the furnace are consumed, the electrode position is automatically adjusted by hydraulic means; the burning carbon also provides a reducing atmosphere in the melting furnace.

After a predetermined number of watt-hours, as indicated on a meter, the current is shut off. Molten bronze is then poured from the initial melting furnace into a casting furnace, *Fig.* 3. The tortuous path of travel of the molten metal in entering the casting furnace assures deoxidation and degasification of the melt; reoxidation is prevented by an inert atmosphere (nitrogen) which covers the metal in the casting furnace.

▸ Freezing Zone

From the casting furnace, metal enters the die chamber through one or more small holes by gravity flow. The metal freezes rapidly in the water cooled die and excess heat is removed from the solid metal by means of additional secondary water jackets when necessary.

A diagram of the die and the freezing zone is shown in *Fig.* 4. High quality castings are produced because the rate of freezing and the direction of freezing can be reproducibly controlled. These variables are important in the production of sound bronze castings and are quite difficult to predict for other casting methods, i.e., with sand or permanent molds. It can be seen that the system is essentially a bottom pouring process, which is highly desirable since it allows gas to escape from the freezing zone while dross and dirt collect on top of the molten bronze in the holding furnace.

In beginning the casting of any particular shape, a plug of the same size and composition of the material to be produced is inserted in the bottom of the die. The lower end of the plug is attached to an aluminum "starting rod" of the same diameter. This starting rod is then strung through power driven rolls located directly beneath the casting furnace on the next lower floor of the plant, *Fig.* 5. Metal in the casting furnace welds to the plug in the die as it begins to solidify. The roll drive is then started, and at a predetermined speed the casting cycle is set in motion. The gripper rolls of the drive must maintain a strong pressure on the casting as they support the entire weight of the metal bar or tube. Castings of 9-inch diameter can weigh as much as 200 pounds per foot of length. Secondary cooling jackets provide additional cooling for more comfortable handling of the casting. Up to four such jackets are required for large castings while none is required for small sizes.

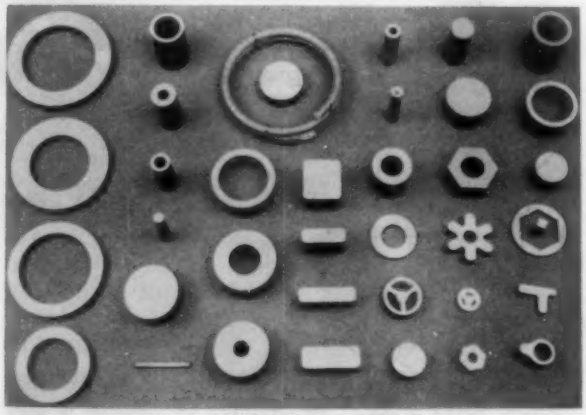


Fig. 2—Examples of both solid and hollow forms which may be continuously cast. Diameter of smallest continuously cast rod is 7/16-inch; largest casting diameter is 9 inches.

▸ Handling Rods and Tubes

From the roll drives, the castings are delivered directly downward to the next floor which contains means of sawing the bar or tube to length, *Fig.* 6. The cutoff saw is engaged at proper intervals to cut lengths to ordered sizes ranging up to 16 feet. As the casting is continuously moving downward,

Fig. 3—Charge is melted in rotary arc furnace and then transferred to electrically heated holding furnace. The arc furnace rocks back and forth during the melting cycle to insure proper mixing of the high leaded bronzes.

the saw moves with the casting, cutting as it travels. Production requirements in the copper billet installation have permitted the use of automatic sawing devices in which the saw automatically cycles in cutting the billet to desired lengths. The sawing operations for the alloy lines are manually controlled.

Cut sections of work drop through to the next floor onto a tilting receiver, and are then rolled onto inspection tables, *Fig.* 7. The tilting receiving unit for large bars or tubes contains a hydraulic buffer, similar to the recoil mechanism of an artillery piece, in order to absorb the shock of the drop. As a final operation, products destined for use as-cast are straightened.

Control Variables

Basically, the process is relatively simple, but a successful casting technique was developed only after years of development of the control methods and devices. The pressure of nitrogen above the molten metal in the casting furnace, temperature of metal in the casting furnace, rate of removal of the cast metal from the freezing zone, and temperature of the water in the cooling jacket are the main control variables which had to be considered. Each casting unit, four in the copper billet plant, five in the alloy plant, is equipped with a master panel which serves as a control center for these variables.

Necessary dry nitrogen is generated in the plant from the combustion of propane and subsequent treatment of the products of combustion. Pressure is controlled by a gage on the control panel.

Temperature of the metal in each casting furnace is recorded at the master panel and is controlled by rheostat-operated graphite resistors in the furnace at the 3000 to 4000F range. This temperature in the furnace is near the top limit of safe operation for the refractory lining, and constant manual attention is preferred as a safety feature.

Rate of removal is controlled by adjusting the speed of the roll drives. The copper plant is supplied with dc current; the bronze plant is supplied with ac current. When casting copper, the speed of the roll drives is controlled automatically by means of a dc General Electric pilot motor generator. An Alnico pilot generator provides exciting voltage to the motor generator to compensate for possible voltage changes and to provide constant speed for the drives. The ac motor drives for the rolls in the alloy plant are not subject to a critical voltage variation, and additional speed controls are not required.

The automatic speed recorder on the control panel is calibrated in inches per minute. The linear rate of casting varies considerably with the diameter and/or weight per foot of the casting. For example, variation in the weight of bronze ranges from as little as 0.85 pound per foot of length to the previously indicated high of 200 pounds per foot of length.

The system for cooling water provides for the normal recording of inlet and outlet temperatures, a continuously recirculating system including a water tower, and standby facilities to insure safety for equipment in event of power failures.

Die Details

The heart of the casting unit is the graphite die —and its invention was one of the phases of the early development work that made the continuous casting process possible. Properly tapered, dense graphite produces a nonsticking high conductivity surface. The dies are relatively inexpensive and

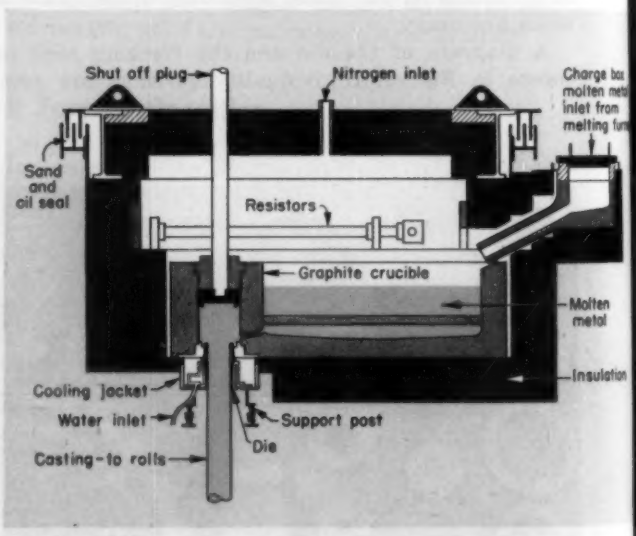


Fig. 4—Details of the holding furnace and die in which freezing takes place. Temperature in furnace is held by heat supplied by resistors. Graphite dies are expendable and easily replaced. Separate die and jacket construction permits flexibility in production as to forms cast.

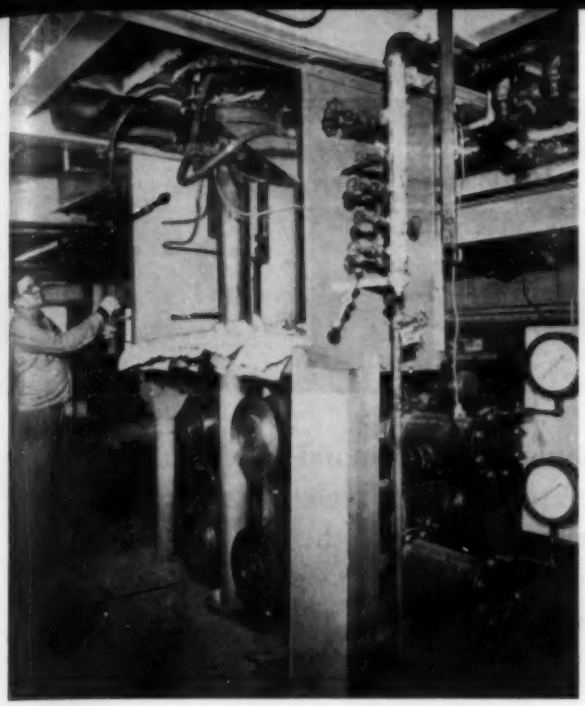


Fig. 5—Electrically powered rolls control the speed of casting by the rate solidified metal is withdrawn from freezing zone and die. Accurate speed control of these rolls is critically important to successful operation of the system.

Fig. 6—Saw moves downward with moving casting while completing its cut. In this application when length is sliced off, saw returns automatically to its upper position, ready for the next cut.

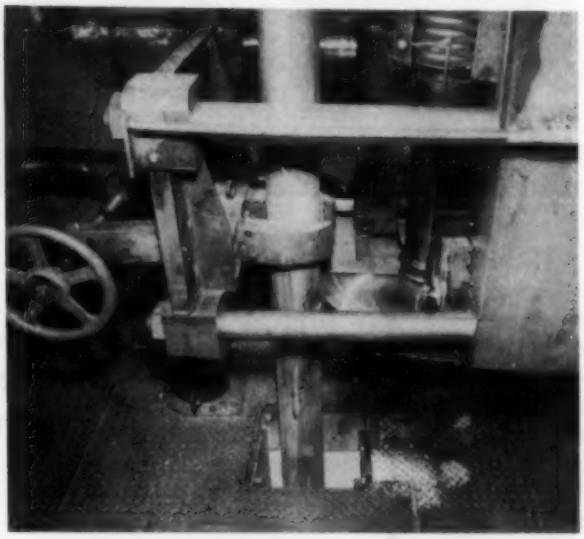
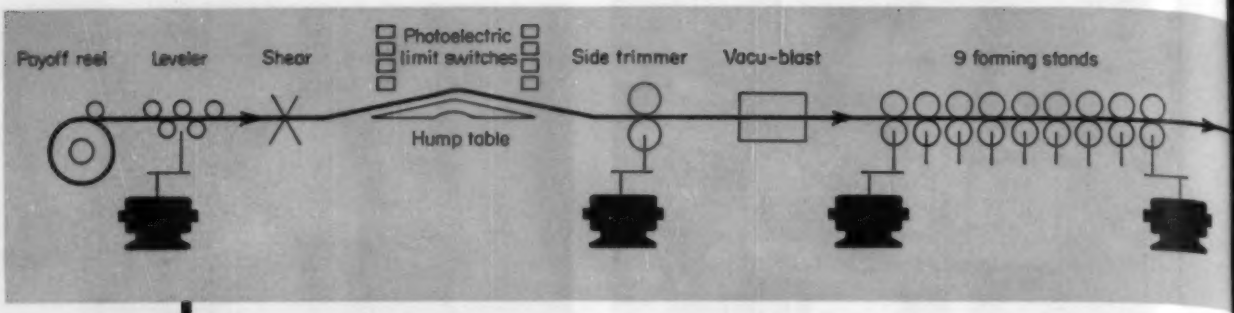


Fig. 7—Large diameter bars or tubes drop from saw floor into tilting receiver equipped with hydraulic buffer to absorb shock. Parts are then ejected onto roller conveyor for inspection prior to straightening operation.

are expendable—for bronze the average life is only 24 hours. The machined graphite dies are fitted to the cooling jacket by means of a matching taper for easy replacement. A threaded section above the taper serves as a means for location. The inside of the die is also tapered to allow for dimensional changes during freezing, a design consideration which depends on the alloy being cast and the actual shape of the casting. Rod dies may contain one, two, three or five holes, also depending on the alloy and shape being cast. Tube dies are constructed on the principle of the bridge dies used in extrusion processes with the important difference that the bridge is completely surrounded by molten metal. The rigid short-couple mounting of all types of dies in the mandrel provides for close control of wall thicknesses which generally vary not more than $\pm 1\frac{1}{2}$ per cent of its nominal dimension. The design of the die provides for flexibility in changing dies and this is a major factor in making small quantity runs of special sizes and shapes economical. This is, of course, one of the most important features making feasible the continuous casting of a variety of shapes. Without versatility, variety of demand could not be satisfied on an economical basis. An idea of the demand for continuous cast bronze products is contained in the production figures—approximately one million pounds per month are made in the five casting units. Electricity has a big part in the process. Asarco's plant consumes between 400,000 kwh and 600,000 kwh per month.

Economical use of continuous cast bars and rods in bearings, bushings and other industrial applications is enhanced by the superior physical qualities of the product. Thus these continuous casting installations illustrate an often proved fact about automation in general: Even though developed originally for economic reasons, it has been found that more consistent quality work can be produced because closer control of a continuous process is possible.

The author wishes to acknowledge the assistance of J. S. Smart and the American Smelting & Refining Co. in the preparation of this article.



Modern markets for tubular goods demand better quality, closer cost control, and higher production levels in producing plants. Part of the answer in pipe mills—as in other industries—is application of automatic controls to continuous processes. The author describes a development in this field.

AUTOMATIC CONTROLS

IN PIPE PRODUCTION

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IN RECENT YEARS the trend in the business of making tubular metal products has been toward the continuous mill. This has been especially true in manufacture of welded tubular products and has been strengthened by the use of: (1) Adjustable voltage dc drives for all strip forming and propelling equipment, (2) simple lever and cam type limit switches for initiating specific operations in proper sequence as strip progresses through the line, (3) feedback control systems to control the speed level of the line and co-ordinate the various sections of the line, and (4) quality control features, including feedback control systems and devices for continuous measuring to maintain product quality.

For welded tubular products, the butt weld, the lap weld and the electric weld processes are used, with variations of each to suit the manufacturer and the product. Raw materials used for these processes are coils of hot rolled strip, called skelp, with square or slightly beveled edges.

As an illustration of the trend to continuous tube making, let us examine briefly one mill, an electric weld pipe mill. A simple schematic flow diagram of a 12-inch pipe mill with maximum delivery speed of 120 fpm is shown in *Fig.* 1. The operation of the entire line is continuous and automatic with three exceptions; the loading of a coil weighing as much as 10 tons on the uncoiler, the shearing of the front end of the coil, and the starting of the leveler drive for each coil. For example, after a coil is loaded, jogged through the leveler rolls, and sheared, the entire line is accelerated under adjustable voltage control to a preset running speed. The strip then proceeds through the various processes shown. Limit switches ahead of each of the following processes —vacu-blasting, welding, flash trimming, annealing, and flying cutoff—turn on the processes as the strip or pipe approaches and turn off the processes as the strip or pipe leaves.

Forming, welding, and strip propelling drives are all powered by dc motors in an adjustable voltage arrangement with voltage and speed regulating systems co-ordinating the complete line. The simplified one line diagram in *Fig.* 2 illustrates

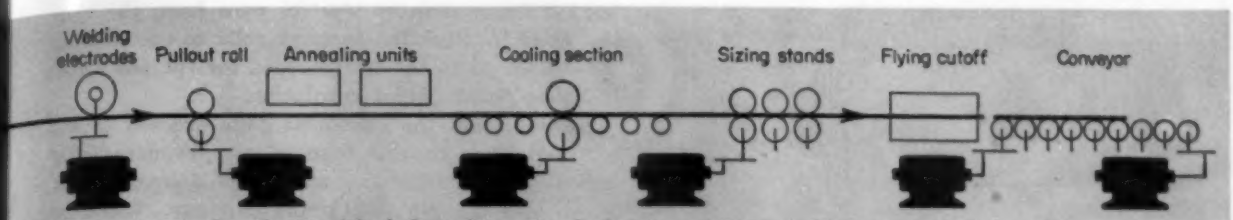


Fig. 1—Simplified flow diagram of electric weld pipe mill showing major units and dc adjustable speed drives.

the speed-voltage regulators which control the dc adjustable voltage drives.

Welding Control

In a mill of this type, the quality of the weld is of the utmost importance. The precentage of salable product depends upon this factor. Two major variables affect the weld power required—strip speed and thickness. Weld power, therefore, is controlled automatically and continuously as a function of these two variables. Weld power is regulated as a function of the square root of line speed by a system controlling the output voltage of the high frequency alternator supplying the welding transformer. A one line diagram of this system is shown in *Fig.* 3.

Control of weld power as a function of strip thickness is somewhat more complicated. Since it is impossible to measure pipe wall thickness at the weld point, the strip thickness is measured ahead of the forming stands, while the strip is still flat, and the measurement signal is delayed until that portion of the strip measured is under the welding electrodes. The signal then operates the alternator voltage regulator to adjust voltage as a function of strip thickness. A schematic sketch of this control is shown in *Fig.* 4.

Operation of this control may be described as follows. An Electrolimit gage is located on the flat portion of the strip and measures the metal thickness. An electromagnetic pickup is used in this gage. The thickness of the steel varies the inductance of the pickup, thus producing a phase sensitive ac signal. This signal is rectified and becomes the input signal to the Proportional Syncronizer, which stores the signal until the area of the strip measured reaches the welding electrodes.

The synchronizing device consists of a pin wheel with 360 spring loaded pins, a pin positioning carriage at the bottom of wheel, a servoamplifier in the base of the synchronizer, and a small motor which sets the pin positioning carriage. The pin wheel is chain-driven by the pipe line, and therefore its speed is proportional to pipe speed. The gear ratio of the drive is such that the time delay

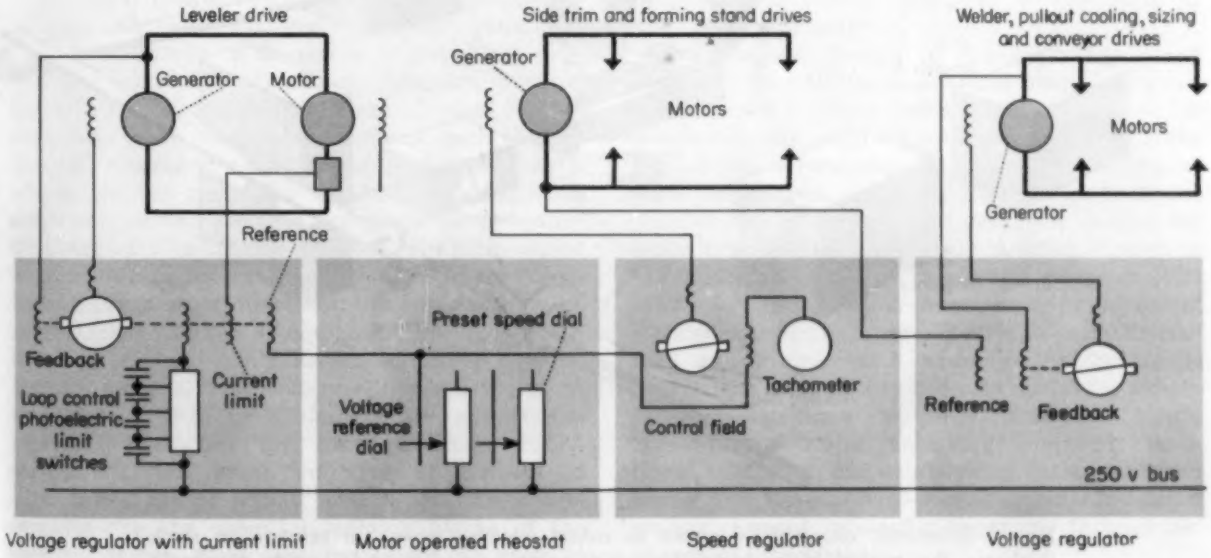


Fig. 2—Speed of all units of the electric weld pipe mill must be co-ordinated. This simple diagram illustrates the circuits regulating speed of the dc drive motors by adjusting voltage.

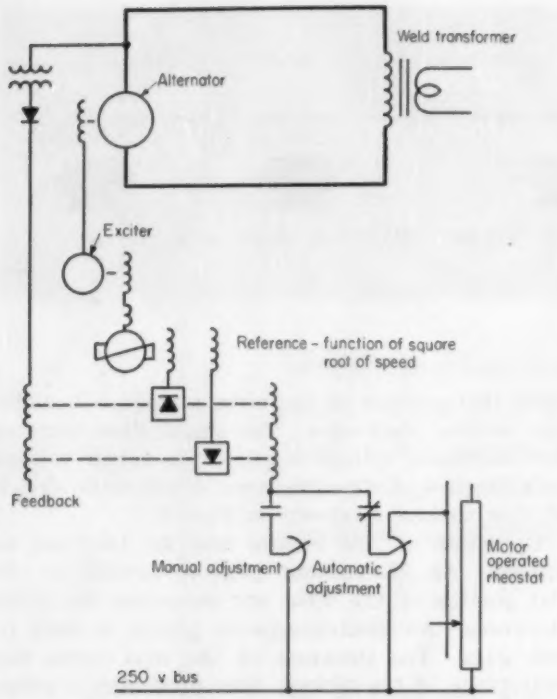


Fig. 3—One-line diagram of system to regulate welding power as a function of the square root of tubing speed. Tubing speed is one of two major factors in determining the correct welding power to obtain sound welds.

needed for a strip of steel to pass from the electric gage through the forming rolls to the welding head is equal to the time needed for the pin wheel to make about half a revolution.

Signals from the thickness gage are fed to the servoamplifier in the base of the synchronizing unit. This amplifier in turn drives a small motor which sets the pin positioning carriage. When no signal is received from the gage, this means that the steel strip thickness is equal to gage setting and the pin positioning carriage remains in the center. If the metal thickness changes, the signal received by the servoamplifier will cause the carriage to be moved in a direction corresponding to the change, thus moving every pin that passes through it thereafter. At the top of the wheel a differential transformer is located so that it detects the position of the pin and produces an electrical signal proportional to pin position. This signal is fed into the control windings of the magnetic amplifier (amplistat) and is fed in turn into an amplidyne to control the field of the alternator which supplies single phase power to the welding transformer. The amplidyne control signal is thus varied in proportion to steel strip thickness.

Application of such control devices is not limited of course to tube mills, and many production people in other fields can profitably apply similar techniques to their own operations.

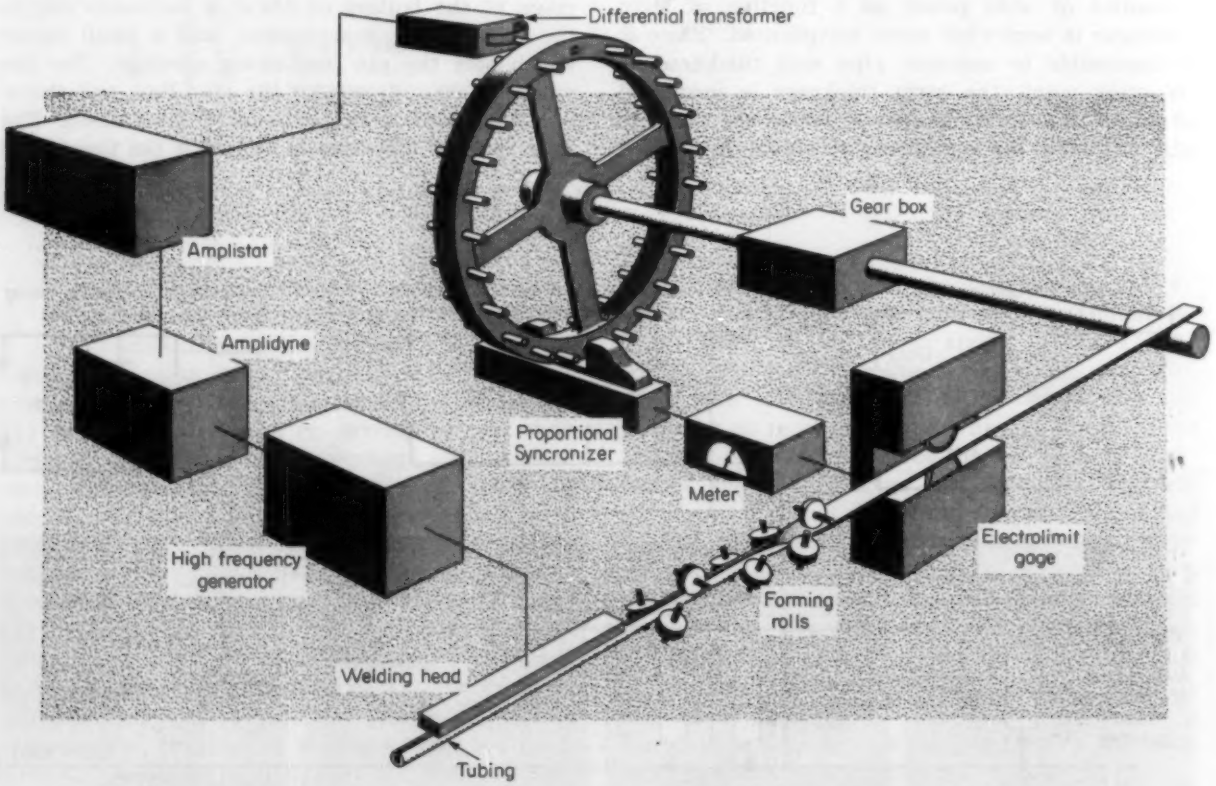


Fig. 4—Schematic diagram of system to adjust welding power in relation to stock thickness, the second major factor for which compensation must be made to obtain good welds. The Proportional Syncronizer serves as a memory device with a storage time equal to that required by a point on the strip to travel from the thickness gage to the welding head.

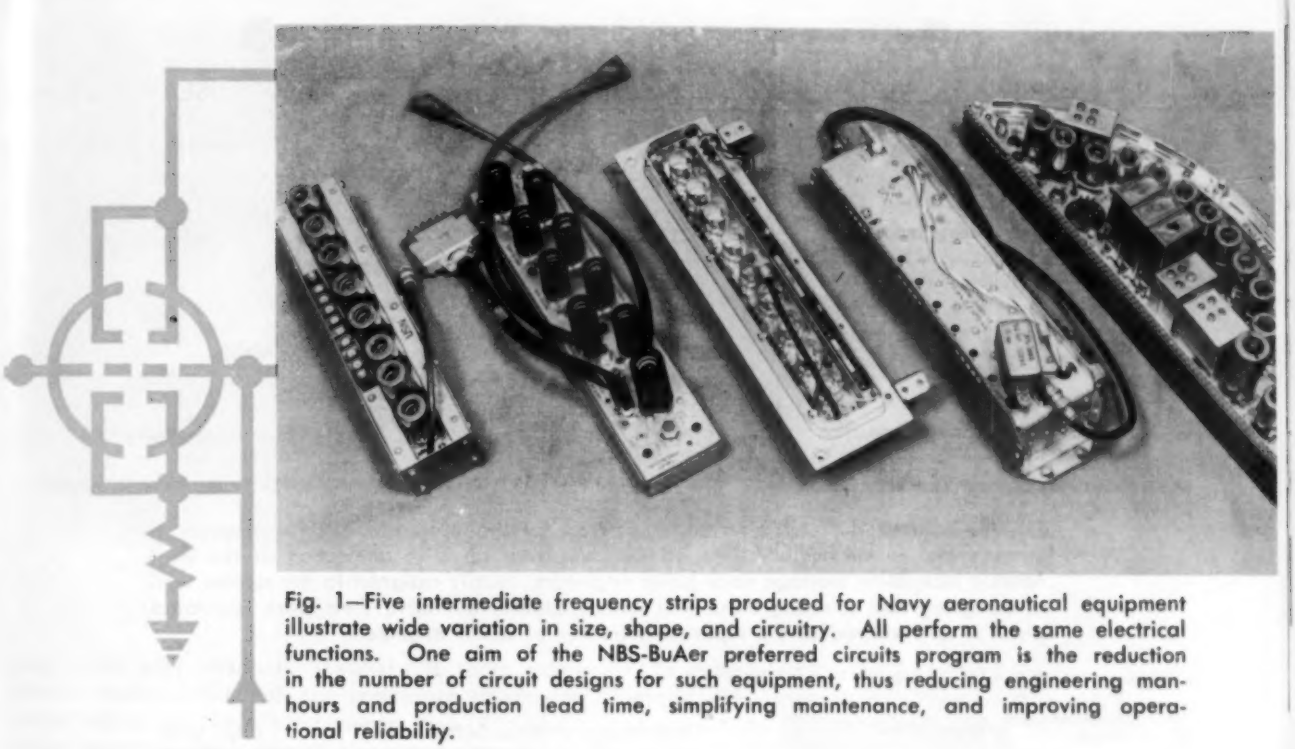


Fig. 1—Five intermediate frequency strips produced for Navy aeronautical equipment illustrate wide variation in size, shape, and circuitry. All perform the same electrical functions. One aim of the NBS-BuAer preferred circuits program is the reduction in the number of circuit designs for such equipment, thus reducing engineering man-hours and production lead time, simplifying maintenance, and improving operational reliability.

ELECTRONICS ADVANCED BY

CIRCUIT STANDARDIZATION

CIRCUITS of much electronic equipment are of necessity extremely complex, consisting of hundreds or thousands of individual components (resistors, capacitors, inductors, vacuum tubes, etc.) connected by a maze of wires. However, like other complex mechanisms, such circuits do not represent a single entity designed as a whole for its particular function. Rather, this electronic equipment is a composite of many individual smaller circuits, most of which utilize known techniques in forming different combinations having other functions. For example, most aeronautical electronic equipment includes rectifier circuits, and many include amplifier circuits, timing circuits, and others. Some circuits in a complete piece of equipment are unique and especially designed for that particular equipment, but the great majority of circuits in any device are of widely used types. Such subcircuits are the essential building blocks of the overall design. They are recognized as such in the "block diagram" language of electronic circuitry, in which the overall circuit is represented in elementary form by a number of labeled rectangles, each corresponding to a subcircuit of known characteristics.

The National Bureau of Standards has found that it is feasible to standardize many electronic circuits used in Navy aeronautical equipment. A standardization program, undertaken for the Navy Bureau of Aeronautics, is seeking to determine those well-known circuit configurations that are common to a wide variety of electronic devices but which now differ unnecessarily in detail. Known as the NBS-BuAer preferred circuits program, this continuing investigation may result in important economies in critical engineering man-hours, in lead time, and in accelerated production. It also should provide the military services with means for simplifying maintenance training, designing simple "throw-away" units, achieving improved operational reliability, and establishing design standard levels. The Bureau is co-operating with industrial groups engaged in similar programs through exchange of information.

Although many electronic building blocks have become widely accepted for their general function and circuit arrangement, up to this time no at-

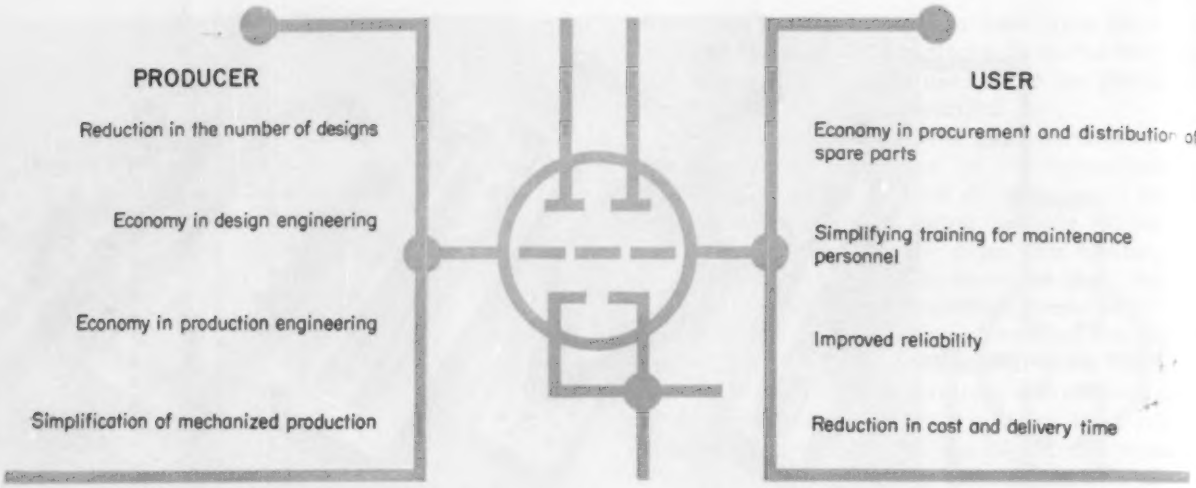

PRODUCER
Reduction in the number of designs
Economy in design engineering
Economy in production engineering
Simplification of mechanized production
USER
Economy in procurement and distribution of spare parts
Simplifying training for maintenance personnel
Improved reliability
Reduction in cost and delivery time

Fig. 2—Diagram showing advantages offered by the preferred circuits program to industry and to the military. An additional advantage is in alleviation of the engineering manpower shortage since junior engineers, usually assigned to the routine work of designing and selecting these well known circuits, will have their work facilitated, which in turn will reduce the supervisory burden of senior engineers.

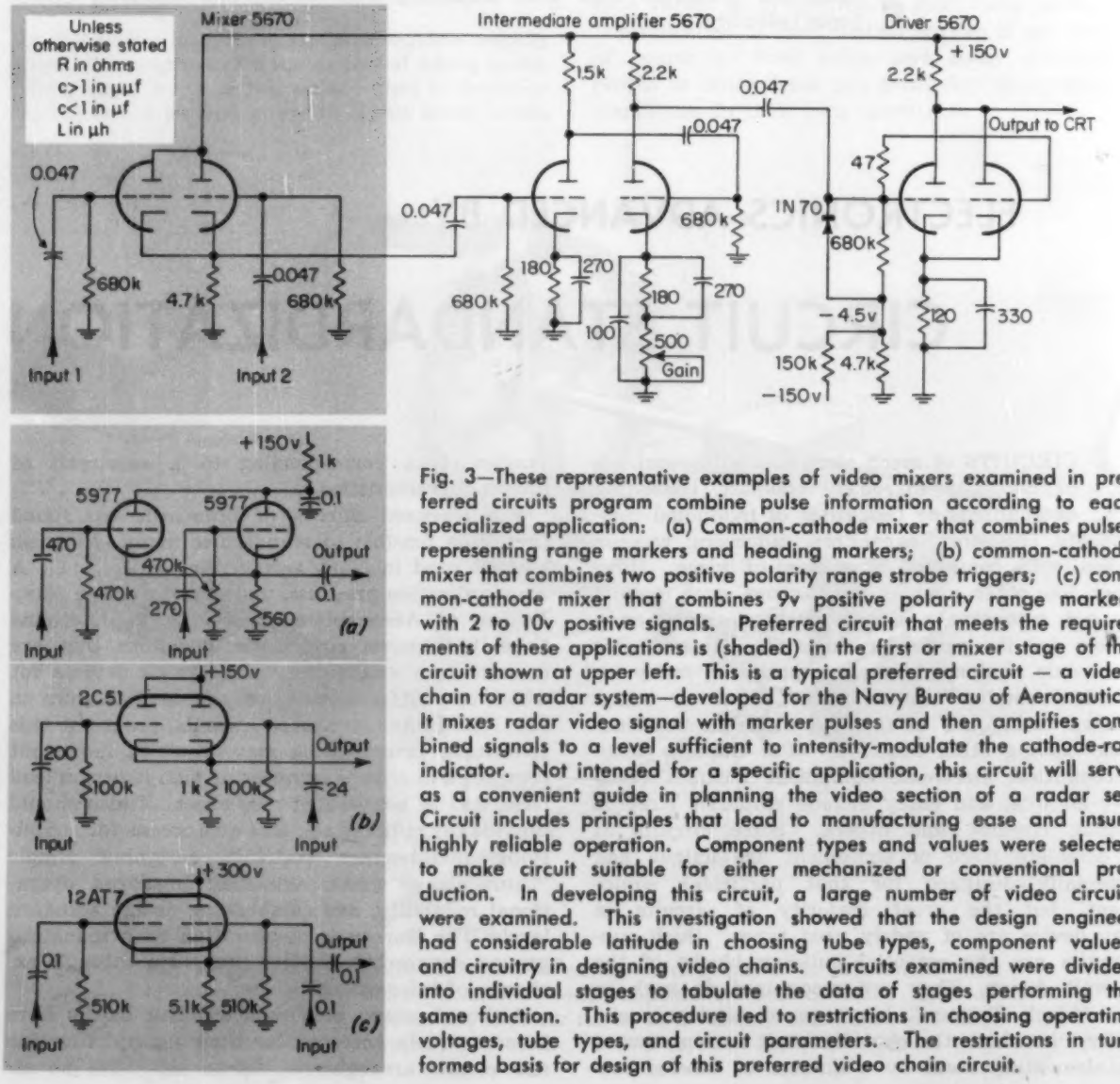


Fig. 3—These representative examples of video mixers examined in preferred circuits program combine pulse information according to each specialized application: (a) Common-cathode mixer that combines pulses representing range markers and heading markers; (b) common-cathode mixer that combines two positive polarity range strobe triggers; (c) common-cathode mixer that combines 9v positive polarity range markers with 2 to 10v positive signals. Preferred circuit that meets the requirements of these applications is (shaded) in the first or mixer stage of the circuit shown at upper left. This is a typical preferred circuit — a video chain for a radar system—developed for the Navy Bureau of Aeronautics. It mixes radar video signal with marker pulses and then amplifies combined signals to a level sufficient to intensity-modulate the cathode-ray indicator. Not intended for a specific application, this circuit will serve as a convenient guide in planning the video section of a radar set. Circuit includes principles that lead to manufacturing ease and insure highly reliable operation. Component types and values were selected to make circuit suitable for either mechanized or conventional production. In developing this circuit, a large number of video circuits were examined. This investigation showed that the design engineer had considerable latitude in choosing tube types, component values, and circuitry in designing video chains. Circuits examined were divided into individual stages to tabulate the data of stages performing the same function. This procedure led to restrictions in choosing operating voltages, tube types, and circuit parameters. The restrictions in turn formed basis for design of this preferred video chain circuit.

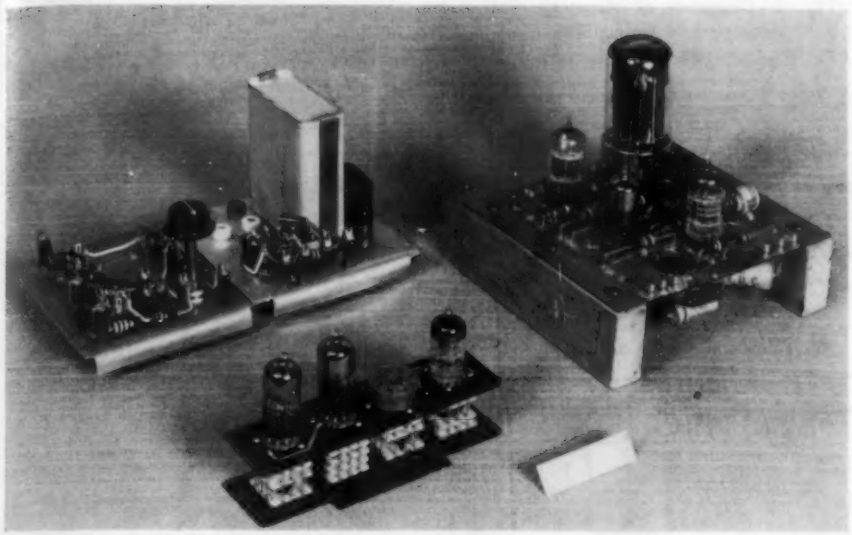


Fig. 4—Preferred circuits are readily adaptable to such different construction methods as mechanized production, printed circuitry, or laboratory breadboard techniques. Three different preferred circuits built by three different fabrication techniques are shown.

tempt has been made to standardize their exact circuit configurations or the resistance or capacitance values of their components, *Fig.* 1. Engineers recognize that one of the great advantages of electronic techniques is the flexibility of the circuits, both during design and production, since an electronic assembly consists of many parts that may be rather easily replaced by others. Electronic engineers are naturally reluctant to surrender this flexibility except for great compensating advantages. Nevertheless, preliminary consideration by the Bureau of Aeronautics and a feasibility study by NBS showed that the standardization of circuits used in aeronautical electronic equipment should result in worthwhile advantages to both the military user and the industrial producer, *Fig.* 2.

Feasibility Study

The initial feasibility study, undertaken in 1953, consisted of a detailed examination of 22 carefully selected items of aeronautical electronic equipment. These included several different radar sets, an indicator assembly, radio equipment, and others. Sources of information included instruction manuals, specifications, and the experience and advice of equipment engineers and maintenance personnel. The overall circuits were divided into functional subcircuits and then subjected to systematic analysis of the detailed circuit differences and of design parameters. Considerable attention was given to establishing a common terminology, as different equipment designers may use widely different names for essentially the same circuit.

Results showed that the overall circuits of the 22 systems essentially were made up of 60 circuit types. Although the circuits falling within a given type were not identical, in many cases examination showed that these circuits were sufficiently similar in their more important aspects so that standardization would be feasible, *Fig.* 3.

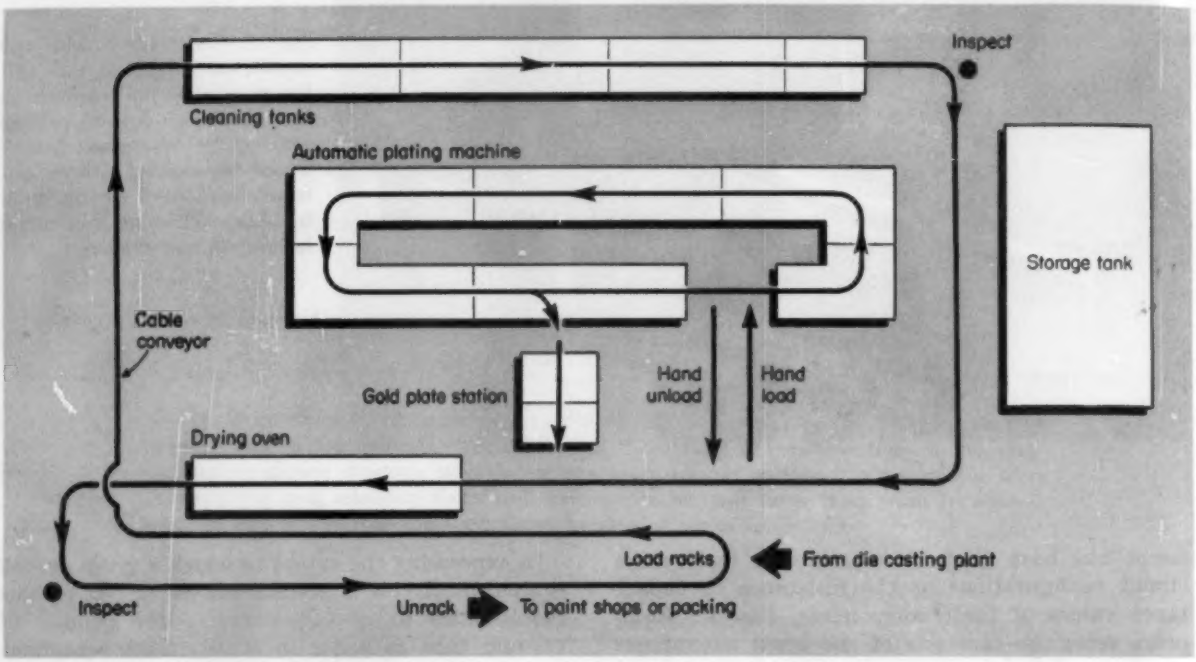
In expressing the extent to which a given overall equipment circuit is standardizable, it has become the practice to use the ratio of the number of vacuum tube cathodes in standardizable portions of the circuit to the number of cathodes in the overall circuit. Cathodes are counted instead of entire vacuum tubes to avoid ambiguity resulting from such items as double triodes. On this basis, the feasibility study of the 22 pieces of equipment showed that 50 to 70 per cent of the cathodes were standardizable. The remaining cathodes were in circuits too specialized to hold any reasonable prospect of standardization.

Most promising field of standardization was in the power supply circuits which were considered to be standardizable in all of the systems. It was also immediately evident that the first step should be the reduction of the unreasonably large number of power supply voltages. For example, it was found that the voltages used in 20 systems showed 20 different nominal values which appeared readily reducible to four.

As a result of the favorable outcome of the feasibility study, work was immediately started on the preferred circuits program. Priority has been given to the most widely used and readily standardizable items, *Fig.* 4. Work on any given circuit has required both theoretical and experimental studies of the known versions, so that a "least common denominator" circuit can be established. The preferred circuit is usually chosen from one of the existing designs, with required variations allowed by prescribed component value changes. As a result, the circuit is capable of equaling the performance while avoiding the faults of a large number of "original" versions. In no cases were completely new circuits designed.

The Bureau's preferred circuits are not offered as definitive solutions to the electronic design engineer's problems. However, the circuits so far published appear to be as good as those in common use and to be capable of definitely stated performance.

Fig. 1—Diagram of cleaning and plating operations of Lee Silver Service Inc. Full Automatic plating machine was engineered and built by Udylite Corp. Gold plating is the only hand plating operation in the shop.



AUTOMATIC PLATING SETUP

PROCESSES VARIETY OF CASTINGS

The usefulness of partially automated operations is not measured by what machines cannot do — but rather by what machines can do. Thus, the use of manual labor does not detract from the real progress which the conveyor and automatic cycling machine have brought to the electroplating industry — quantity production, lower costs, and improved quality.

IN SOME production processes involving substantial quantities, it is the identical treatment of identical parts which forms the basis for automation. However, there are examples of automatic processes where the treatment alone is the constant — individual parts receiving the treatment may vary as to size, shape, etc. Finishing operations are peculiarly adaptable to this latter form of automation. Illustrating this are the modern electroplating facilities of Lee Silver Service Inc., Detroit zinc die casting manufacturer.

The company supplies industry with a wide assortment of escutcheons, name plates, door handles, horn rings and buttons, control panels and the like. The type of items produced and the use for which they are designed create an obvious electroplating problem: The most economical, high quality, uniform metal finish must be produced on many different zinc die cast parts varying in size, shape and intricacy. The solution to the problem involved integrated automatic cleaning and plating lines. The facilities are built around an automatic

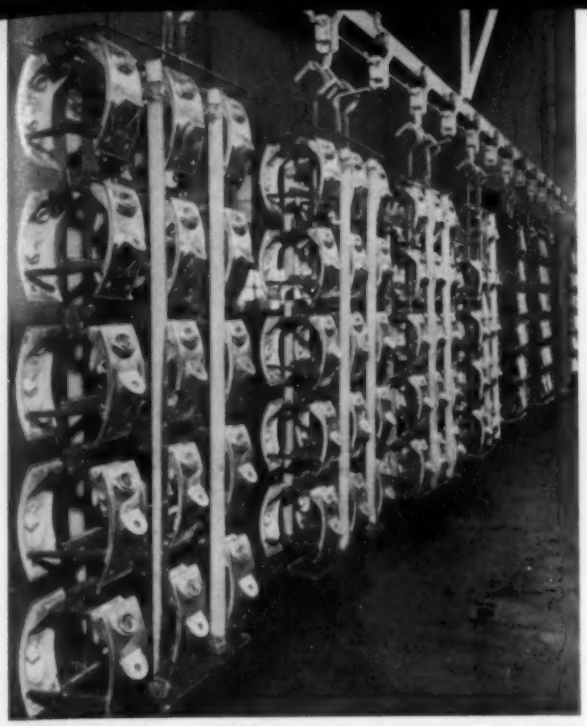


Fig. 2—Zinc die cast pieces are racked and placed on overhead cable conveyor for transporting to cleaning line. Racks in foreground are equipped with special bar anodes (vertical strips) to increase throwing power in chrome plating.

return-type plating machine engineered and built by the Udylite Corp., Detroit, *Fig.* 1.

Cleaning Is Important

In operation, die castings are brought to the plant conveyor by hand truck (this process will be mechanized in the near future) and the parts are then placed on plating racks by hand. Racking the pieces is an especially important operation and each rack is specifically designed to accommodate a particular job. Much of the efficiency of the whole system, together with control of the final plate, depends on proper rack design.

The racks are placed on a cable type Bushman variable speed conveyor and taken at 2 to 6 fpm to cleaning tanks placed along one wall of the plating room, *Fig.* 2. The proper removal of grit and grime left on each casting by the buffing operations is a critical part of the plating cycle. To improve this cleaning operation, freshly buffed die castings are sprayed with a mineral spirits product to keep the buffing compound from hardening and to provide an oil film between the base metal and the soil. The presence of this oil interface greatly aids the subsequent removal of soil in the cleaning operation.

The actual cleaning line consists of a series of tanks, 95 feet in total length, through which the racks are conveyed by the plant conveyor, *Fig.* 3. In the first 30 feet of this line, the parts are soaked in a special cleaner solution to remove the grit bearing mineral spirits. As the racks are lifted out of this first solution to proceed to the next tank, they are sprayed with a light mist of soak solution. The parts are soaked in an alkaline bath for another 30 feet and then sprayed with another special cleaner by a power washing machine in a 25-foot section of the line. Final rinse is with city water for the remaining 10 feet of line length. After this water rinse, each rack and each piece on it are inspected before being conveyed to the electroplating line.

Plating Machine

Transfer from the cleaning and inspection line to the automatic plating machine is a manual operation. At the transfer point, which is both a load and unload station, clean racks are picked off the cleaning line and hooked onto the plating conveyor, and racks of plated parts are taken from the plating machine and returned to the plant rack conveyor to be borne to drying ovens. The controls for the entire system, together with a test panel indicating the condition of the rectifiers at various points in the line, are located at this transfer point.

Movement of racks within the automatic plating machine is by hydraulic means and the operation can be controlled by simple adjustments to hydraulic valves. The work carriers ride directly on a cathode rail which acts both as a support and conductor. Where transfer is required a section of the rail is hydraulically lifted, raising the work

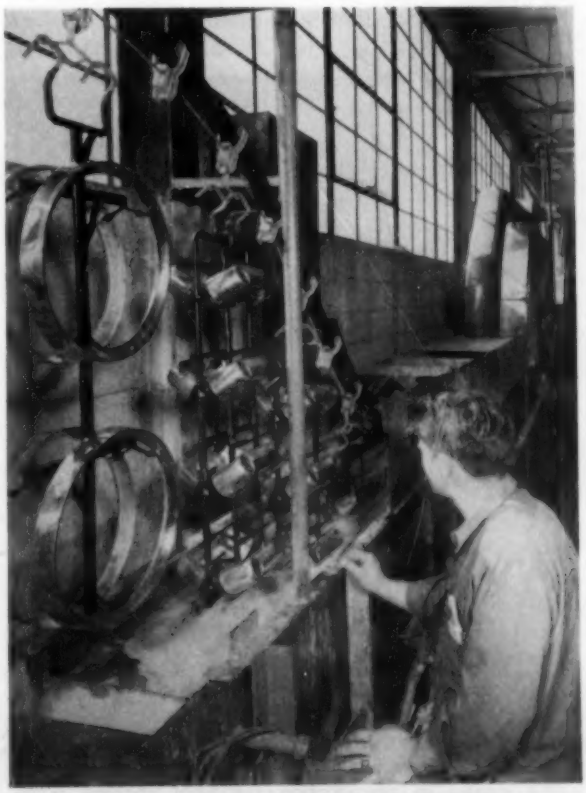


Fig. 3—Parts are conveyed through cleaning line on cable conveyor. The line is 95 feet long and contains three cleaning and one rinsing station.

from the tank; the work carrier is moved by a hydraulic pusher mechanism and the work lowered into the next tank. In other words, by means of a pusher mechanism the work carriers are advanced within tanks when the superstructure is in the down position and transferred from tank to tank when the superstructure is in the up position.

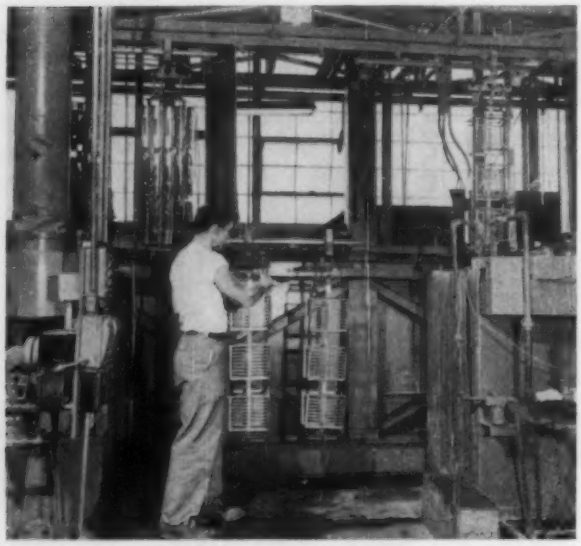


Fig. 4—Control point is located at load-unload station of the automatic plating machine. Parts are manually transferred from and to overhead cable conveyor which passes through both the cleaning bath and final drying oven.

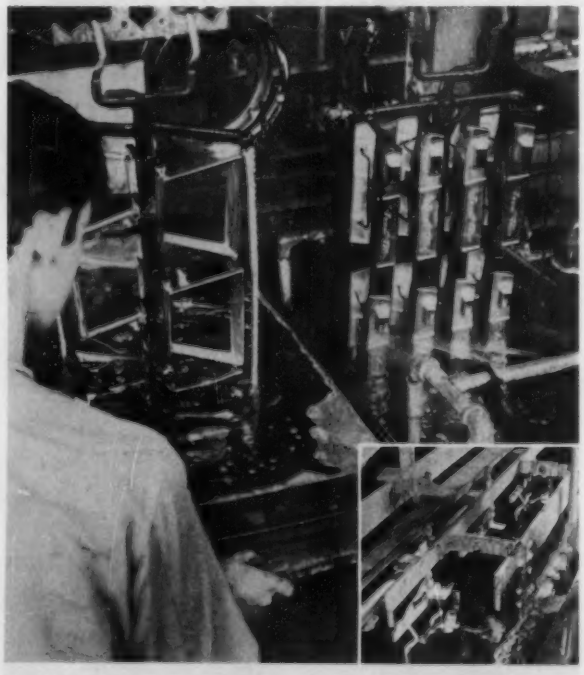


Fig. 5—Parts shown have been nickel plated and are being rinsed in preparation for final chrome plate. Insert shows extra bar above chromium plating tank which makes contact with brush on some racks to improve current flow to parts being processed.

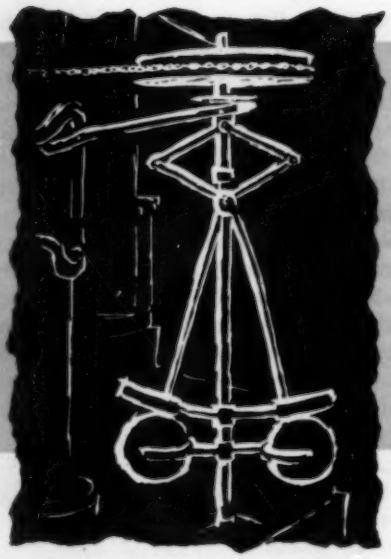
Production rate is 160 racks per hour, or roughly one rack every 35 seconds.

The automatic plating machine provides for continuous, uninterrupted production and accurate timing of treatment for each rack of parts in each tank to insure plating to exact specifications. There are 21 steps in the copper-nickel-chromium plating operation and 20 for a copper-nickel-gold treatment. The plating machine is also provided with several special features. For instance, all rectifiers are connected to a central light panel located at the load-unload point; when one goes out, the operator knows immediately that this is the case, and which rectifier it is, *Fig.* 4. This saves inspection time and keeps the plating line operating at top efficiency.

A special bar located in the chromium plate section acts as a current boost, *Fig.* 5. Some pieces have hard-to-plate areas; these pieces are hung on specially designed racks that bring anodically charged sections down to each piece. This increases the flow of current precisely at the points where such an increase is most effective. The anodically charged sections are attached to a brush arrangement at the top of the rack. When a rack enters the chromium plate bath, the copper brush makes contact with the special anodically charged bar. Current flow is increased and a better plate results.

There is a station located just before the chromium plate section of the machine and just after the various rinses that follow the nickel plate section. Here, racks may be removed and placed in special gold or silver plating solutions. This gold plate station is so situated that it is also near the drying ovens and the main plant rack conveyor that serves it. As a result, pieces may be gold or silver plated without upsetting the normal plating cycle. Up to this point treatment of these special racks is automatic, just as it is for racks carrying the parts receiving the usual chrome plating. Such pieces are cleaned, inspected, copper and nickel plated as are all other pieces. Before the final plate, however, they are manually lifted off the plating line, placed in the gold plating bath, timed, rinsed and sent to the drying ovens and final inspection by way of the plant conveyor. Thus, racks to be gold plated can be intermixed with racks to be nickel plated, and the efficiency and uniformity of the whole process maintained.

The value of an automatic installation to this company can best be illustrated by quoting the president, Lee Radke, "Our growth has paralleled our adoption and development of automation. Actually, we purchased automatic equipment ahead of our needs and made our business grow up to its capacity. Our plating machine, engineered to our needs, has given us complete plating control and has greatly increased production per man hour. Its paradox is that in spite of increased production, it brought us such an increase of business that our total employment has increased. Before the purchase of the full automatic, we had 50 employees, now we have four times that number. And we are now doing ten times the business we did back in the hand operation days."



CONTROL SYSTEMS SIMPLIFIED

This is an article for the neophyte to control systems and perhaps refreshingly simple reading for the old hand. If you have been searching for an explanation of control systems that "starts at the beginning" this is an article for you.

By R. H. MACMILLAN
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University of Cambridge
Cambridge, England

EARLY CONTROL devices were designed on the basis of previous experience coupled to trial and error. So long as one is content with controls that are relatively inaccurate and slow in response, no great problems of design arise. But as soon as we wish to improve the performance or even go a stage further and obtain the best possible performance in given circumstances, we must look at the underlying theory—the mathematics—of these devices.

However, to explain the nature and results of this theoretical work without the difficulty of mathematical analysis, it is convenient to take as an example a thermostatically controlled central heating system, as its familiar behavior aptly illustrates general principles.

First step toward improving the performance of a control system is to use a closed sequence to compensate for the effect of random disturbances. This means that the controller measures the actual value of the controlled quantity, which might be the temperature of a house, and compares it with the desired value, which has been set on the controller. The sequence of operation here is closed, since the error determines the controller action, which in its turn reduces the error. The amount of action taken for a particular size of error is called the sensitivity. As the sensitivity is increased the system responds more rapidly and usually controls more closely, but there is a limit to the sensitivity that it is possible to use.

Over a hundred years ago, the Astronomer Royal, Sir George Airy, was concerned with the design of speed regulators for his telescopes to give them a rotation exactly equal and opposite to that of the earth so that they would point in a fixed direction. He devised several mechanisms for this purpose, but in every case he found that as he increased the sensitivity and reduced friction between the parts to secure greater accuracy, a stage was reached at which the control did not operate smoothly at all—the telescope motion became uneven, periodically accelerating and decelerating with increasing violence. This form of oscillation has since been called hunting.

The question naturally arose: Was the tendency to hunt when the accuracy was increased a characteristic of all regulators? It was desirable to know, in addition, whether there was a practical upper limit to the accuracy attainable and, if so, what it might be. There is, of course, a profound difference between the mere recognition that closed sequence controls are liable to hunt and the formulation of a theory that will give precise answers to questions such as these. Airy's own analysis of his telescope controls was published as long ago as 1840. He showed that hunting might be expected to occur if the natural period of vibration of the regulating mechanism was closely related to its period of rotation. This led him to propose modifi-

Mr. Macmillan's article forms a chapter in his forthcoming book *Automation* to be published by Cambridge University Press.

cations which were found, when tried, to improve their performance sufficiently for his purpose.

The next major contribution came from Clerk Maxwell, the genius who predicted the existence of wireless waves before they had been detected physically. This great applied mathematician was also the father of automatic control theory, for the methods of analysis which he introduced were very much more general in conception than those of Airy, and were in fact the only ones available until twenty or so years ago.

It is not surprising that Maxwell made such an outstanding contribution to control theory when one recalls his extraordinary abilities. His first scientific paper was published when he was fifteen years old and he was elected professor at London University when he was only twenty-four. He decided to go into retirement after ten years there, and it was during this period that he made his researches on speed regulators, but six years later he returned to Cambridge as the first professor of physics at the new Cavendish Laboratory and it was then that he did his celebrated work on electromagnetism.

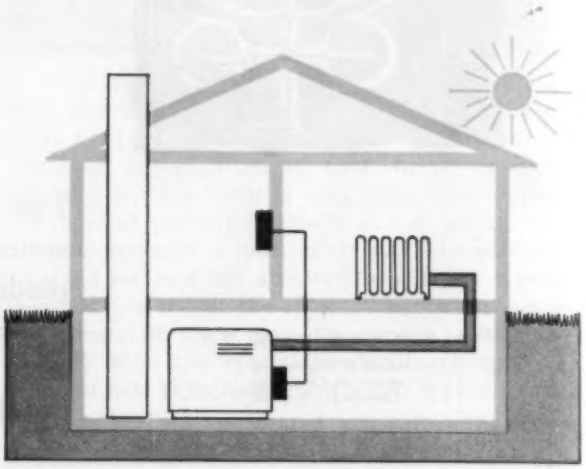
Closed Loop System

In order to appreciate Maxwell's work, we must first discuss in more detail the types of behavior to be expected from a closed sequence control system. Let us consider, for example, a central heating system with a thermostat, that automatically cuts down the heat supplied by the boiler when the temperature of the house exceeds the desired value.

What happens if, when conditions are steady, we wish to raise the temperature of the house by, say 5 degrees? The knob indicating desired temperature is moved to the new value, and the thermostat thereupon takes action appropriate to an error in temperature 5 degrees low. Naturally the house does not get hotter immediately, as the boiler must first raise the temperature of the water circulating in the radiators. When the house eventually does reach the desired temperature, it will go on getting hotter, because of the excess heat that is by then stored in the radiators. It follows, then, that the temperature of the house overshoots the desired value; and a similar argument shows that on cooling down again, it undershoots it. The cycle is then repeated.

Probably the sizes of the overshoots will progressively diminish, until the house finally settles to a fixed temperature, and conditions are again steady; such a system is said to be stable. But if the sensitivity of the thermostat is increased enough, an increasing temperature fluctuation may occur, and the system is unstable. When the sensitivity of the control is very low, on the other hand, there may be no overshooting and oscillation at all. The particular type of response thus depends, not so much on the nature of the control system (provided it is error actuated) as on its sensitivity.

Now, it is often important to know not only about the immediate consequence of a disturbance, but also about the state of affairs achieved later, when conditions have again become steady. When the central heating system is operating at a steady temperature, the heat supplied to the radiators from the boiler is just equal to the heat lost from the house, through the walls and roof. But what happens if the outside temperature drops, or it gets



First step toward improving the performance of a control system is to use a closed sequence to compensate for the effect of random disturbances. This means that the controller measures the actual value of the controlled quantity—the temperature in the house—and compares it with the desired value which has been set on the controller or thermostat.

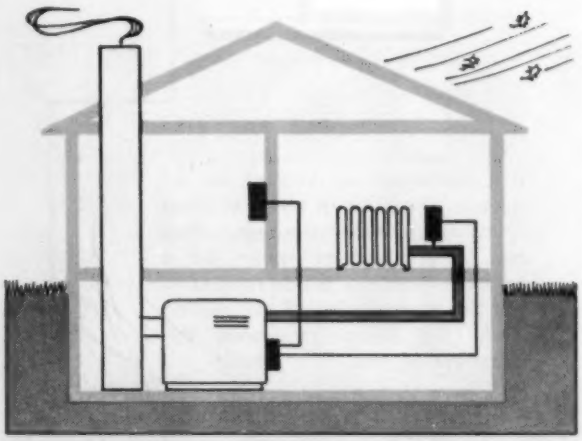
windy? The house now loses heat faster, so there must be a greater supply of heat from the boiler to attain a steady state again. But the boiler heat supply is only increased when the thermostat receives an error signal, which means that the temperature of the house must be below its desired value. It follows that when it gets cooler outside, the temperature of the house must inevitably drop to some extent, though very much less than it would in the absence of any control. All simple regulators must behave like this: A lasting disturbance causes a persistent error that is large enough to produce a control action sufficient to compensate for the disturbance. So it is evident that the greater the sensitivity of the controller, the smaller is the persistent error caused by a particular disturbance.

A small drop in temperature would not usually matter in a dwelling house, but if our thermostat were controlling the temperature of a process in an oil refinery, it might be highly objectionable, for several reasons—a few degrees difference in temperature might seriously lower the grade of petrol produced by the plant or, even worse, a small rise in temperature (during hot weather)

might speed the reaction enough for it to get out of hand and cause an explosion.

When it is important for permanent errors to be eliminated, two methods, which are closely related theoretically, can be used. One way is to make the controller take account not only of the present temperature error but also of the cumulative error. Any persistent error causes this cumulative value to mount steadily, so that the thermostat takes progressively more and more action until the error is eliminated. This type of control is sometimes called reset action, as it is equivalent to automatically resetting the desired temperature to a higher value when there is a tendency for the temperature to be persistently low—which is the way a human operator would achieve the same end.

Alternatively, the controller may be made so that it alters the heat supply continuously at a rate which depends on the temperature error. The heat supply is thus increased steadily until any persistent drop in temperature has been eliminated. The disadvantage both of rate control and of reset



In the central heating system, a simple way of obtaining an estimate of the rate of change of error would be to measure the temperature of the water circulating in the radiators, since the difference between this temperature and that of the house determines the rate at which the house gets hotter.

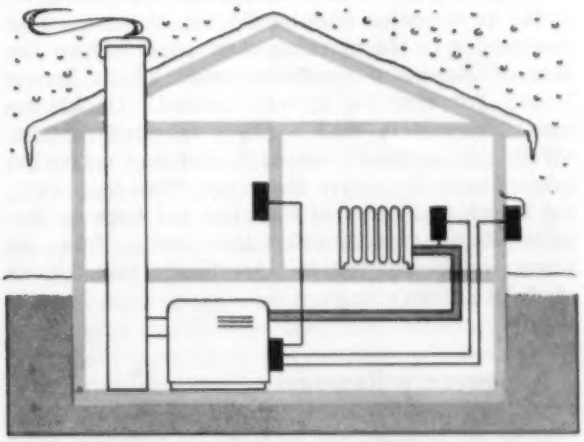
action is that, for the same rate of response, they make the control system much more liable to overshoot. That is, they have an unstabilizing influence.

There are two ways in which it is possible to counteract this tendency to instability, and they were both suggested in principle by Maxwell in 1868. In this classic paper, he first discussed the behavior of speed regulators such as those used by Airy, and then considered those with rate control. He mentioned the existence of the unstable motions we have considered, and remarked that they were genrally disregarded by the inventors of these devices, "who", as he put it, "naturally confine their attention to the way in which they are designed to act". Maxwell then suggested two remedies for this unstable behavior. One of them was to reduce the tendency to oscillate by introducing frictional forces opposing the oscillatory motion—a method still frequently used.

▶ Anticipation of Disturbances

The other method he proposed is equivalent to introducing anticipation into the controller action. This idea is very simple in principle; it will be recalled that in the central heating system we considered earlier there is a tendency to overshoot the desired temperature when the control is too sensitive. This tendency can be reduced by arranging for the thermostat to take less action when the temperature error is diminishing and to take more when it is increasing. This is very like anticipation or prediction, as the controller is always acting now upon its estimate of what the error will be a short time ahead.

With refinements, this is the most commonly used means for achieving stability in control systems today. It involves a measurement, not only of the error, but also of its rate of change. In the central heating system a simple way of obtaining an estimate of the rate of change of error would be to measure the temperature of the water circulating in the radiators, since the difference between



By measuring the outside temperature, there will be a very much more rapid response to changes in the weather instead of response occurring only after the inside temperature of the house has changed.

this temperature and that of the house determines the rate at which the house gets hotter.

It would also be a good plan to use a measurement of the temperature outside to control the boiler, introducing an open sequence feature into this closed sequence system. If this is done, there will be a very much more rapid response to changes in the weather, for compensation for a drop in temperature is then started immediately, instead of occurring only after the temperature of the house itself has fallen.

We have now found that to obtain an ideal central heating system, the controller must take into

account three separate temperatures: First, the house temperature to close the control loop and eliminate permanent errors; second, the radiator temperature to give anticipation; and third, the outside temperature to give immediate warning of disturbance and accelerate the response. It will be a matter of computation and experiment to decide the best proportions in which to use these data to operate the furnace draft control.

To calculate just how much anticipation is needed (that is, how far ahead the control should work in any particular instance) and to find how great the sensitivity should be, to obtain the most rapid and accurate system which is still stable, it is necessary to write equations, as Maxwell did. He found solutions in some of the simpler cases, but the general problem of stating the conditions for any equation to represent a stable motion was solved ten years later by another Cambridge mathematician, E. J. Routh.

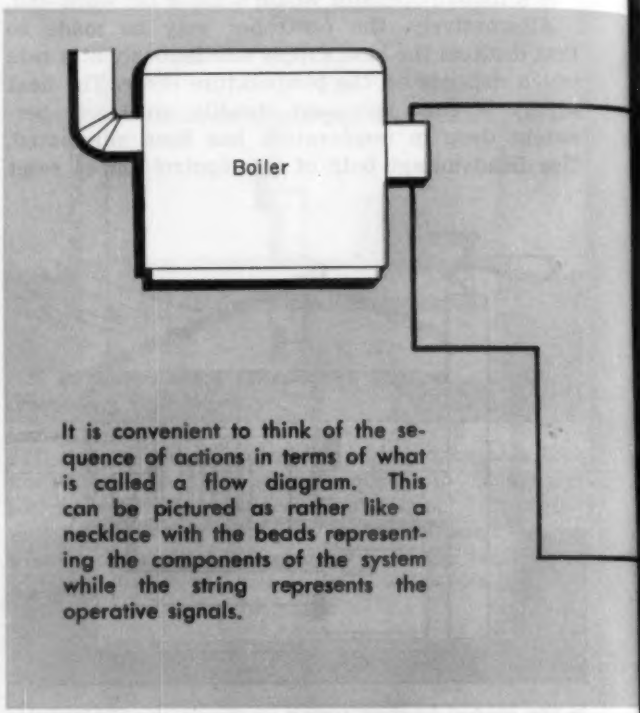
Curiously enough, Routh and Maxwell were undergraduates together and sat for the Mathematical Tripos examination at the same time. An amusing anecdote is told of this occasion. Apparently Maxwell was so confident of his triumph in the examination that he did not even trouble to rise earlier in the morning than usual to hear the lists of successful candidates read in the Senate House, but sent his servant instead. On his return, Maxwell is said to have inquired of him, "Well, tell me who's second!", and was somewhat taken aback to receive the reply, "You are, sir!", for Routh had defeated him. For his work on stability Routh was awarded the Adams Prize, an honor which Maxwell had previously won for his study of Saturn's rings.

▶ Frequency Response

In order to write the equations which represent the behavior of a control system, it is very convenient to think of the sequence of actions in terms of what is called a flow diagram. This can be pictured as rather like a necklace, with the beads representing the components of the system (such as the boiler, the radiators, the house and the thermostat), while the string represents the operative signals (which, in this case, are the various temperatures) that are passed from one component to the next. The necklace can either be left open or clasped into a closed loop, to correspond with the two possible forms of control.

To make use of this flow diagram idea, one must have some means of describing precisely the contribution of each component to the behavior of the system as a whole. This can be done by developing the concept of a time lag, which arose earlier in connection with the central heating system as the interval between the action taken by the controller and the resulting response in the temperature of the house. Every component of the system contributes to this overall time lag which is the sum of their individual time lags. The time lag of each component is a property which does not alter with the type of signal being applied to it. It may be measured experimentally or sometimes calculated from the physical properties of the component.

Suppose now, that instead of considering the effects of applying a single and prolonged disturbance to a control system, we study what happens when it is subjected to a regularly fluctuating signal. As the period of time taken to complete one cycle of disturbance is made less, the time lags will probably not alter greatly, so that they will come to occupy an increasing proportion of a cycle. When they add up to half a cycle, the signals fed back around the loop tend to reinforce at all times the original disturbance and, if the sensitivity is then sufficiently high for the signal which has traveled around the loop to be as strong as the disturbance which originated it, a self-sustained oscillation can arise.

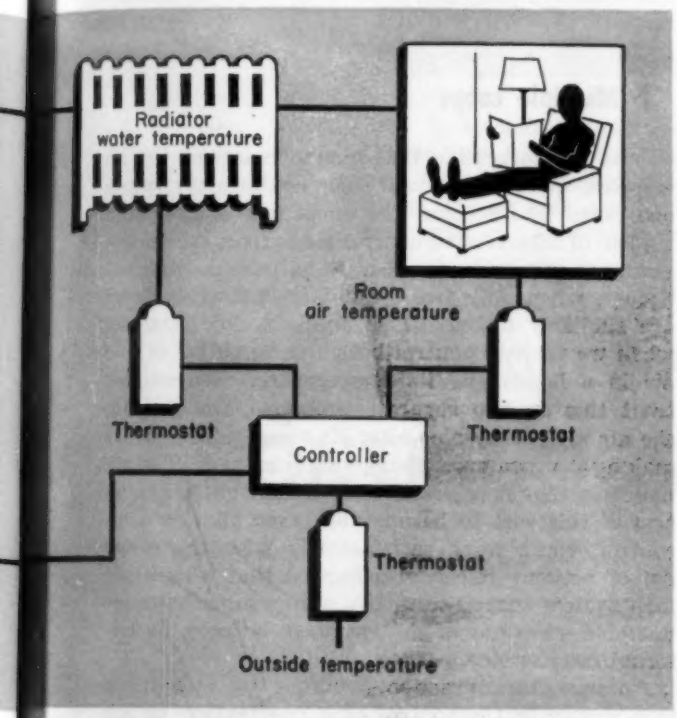


It is convenient to think of the sequence of actions in terms of what is called a flow diagram. This can be pictured as rather like a necklace with the beads representing the components of the system while the string represents the operative signals.

This approach, which was the one introduced by Nyquist twenty years ago in the United States, has two advantages. It provides a practical test procedure for designers and it gives an immediate insight into the factors likely to improve performance. To do this, we must first ensure that all the time lags are as small as is possible, and also reduce the total lag by using anticipation. As we have already found for the central heating system, this may involve a subsidiary feedback of informa-

tion to the controller from some point other than the output.

As far as testing is concerned, the method used is to take each part of the system in turn, apply fluctuating signals to it, and measure its response. When the designer is armed with the frequency response, as this is called, of every component in his system (it is just as important, of course, to know about the process under control as about the control apparatus) mathematical methods have been devised to enable him to choose the best values for the sensitivity and any other factors which may be at his disposal.



Making frequency response tests can be a very costly business when it is necessary to put large units of equipment out of production for the purpose. Finding the characteristics of a typical water turbine driving an electric generator in a plant of the Tennessee Valley Authority, for instance, cost $2000 for each hour of the test. Even so, the results were well worth the expense of obtaining them. Sometimes it is possible to make tests while the system is in normal operation. The largest test of this kind ever undertaken must be that on the Swedish electric grid, covering about 2½ million square miles whose output (in the region of 5 million horsepower) was varied cyclically with periods between 5 and 10 seconds. The time lag was found to be about 6 seconds.

In many systems an important link in the chain of control is a human operator. To analyze the system, it is just as necessary to describe his behavior mathematically as that of any of the other components. Regarded in this light, the input to the human operator is the stimulus, received usually by the eye, and the output is the muscular reaction, which may be a movement or pressure of the hand or foot.

Experiments indicate that the component giving the closest approximation to a human response consists of two sorts of time lag, together with a degree of prediction, the amount of anticipation increasing with training and skill, just as one would expect. But such experiments are liable to give inconsistent results, on account of the variability of human reaction, depending as it does on fatigue and other extraneous influences such as anxiety. In addition, the response to a large stimulus may differ considerably from that caused by a small one, which means that a human being does not behave as a linear component.

▶ Nonlinear Systems

All the controls discussed have been tacitly assumed to be linear, which means that the output from every component increases progressively as its input is increased; if the size of the input is doubled, so is that of the output. The most important characteristic which follows from this assumption of linearity is that when we know the response of the system to a pair of separate disturbances, we can deduce what the response would be if the two disturbances occurred together. This very useful property does not apply to a nonlinear system, and all real systems are to some extent nonlinear.

While there is only one sort of linearity, there are a host of different sorts of nonlinearity, so we must limit ourselves to a few typical examples. One of the commonest is saturation of one of the components. This means that when the input signal to the component becomes sufficiently large, the output ceases to increase further. When a train is full, for instance, the fact that there are still passengers waiting on the platform will not enable it to carry any more. An important consequence of saturation is that the amplitude of oscillation of an unstable system does not increase indefinitely, but mounts to some steady value and then gets no greater. Another nonlinear component is a measuring instrument whose sensitivity varies in different parts of its range. It might be good at measuring medium-sized quantities, but less so at measuring very small or very large ones. A foot-rule is excellent for measuring a length of a few inches, but is hopeless if we wish to measure tenths of an inch or many feet.

A further example of a nonlinear component is the type of controller to be found on an electric iron — there is no gradation in the corrective action. If the temperature of the iron is too low, full power is switched on, and when it is too high the supply is cut off altogether. With many *On-Off* controls of this sort the only steady state possible is a continuous oscillation of small amplitude. *On-Off* controls are very simple and can therefore be made both cheap and reliable, but an

important reason why they are hardly used at all where high performance is demanded is the absence of satisfactory methods of mathematical analysis and design.

This is a difficulty that is by no means confined to *On-Off* controls. Though the theory of linear systems is for the most part worked out, nonlinear theory is still in its infancy. It is the most challenging of the current problems of automatic control and one which is receiving world-wide attention, including that of a group at Cambridge University. It is an extraordinarily important subject, as there is absolutely no reason for supposing that linear systems are the most economical either in power or in first cost. It is also likely that better performance can be obtained from a suitable nonlinear control than from any linear one. Even apart from this, the designer may be forced to use a nonlinear system because of the nature of the components available or of the method of error measurement that must be used.

An example of this is a sampling system. The controller here receives only occasional, instead of continuous, information about the state of the error. On receiving an error signal, it takes appropriate corrective action which lasts unchanged until a further signal enables it to make an adjustment. Interest is added to the theoretical analysis of sampling systems because it seems possible that a human being may also behave intermittently in a manner that is rather similar.

But, as yet, the most important conclusion of research into the behavior of a human operator is that best results will be obtained when his job is made as simple as possible — any prediction that may be necessary being performed automatically. The golden rule for the designer of a system involving a human link turns out to be "Suit the machine to the man, rather than attempting, by elaborate training, to fit the man for a needlessly difficult task."

THE AUTHOR

R. H. MACMILLAN was educated at Felsted School and Emmanuel College, Cambridge, where he took a First Class Honors degree in engineering in 1941. Until 1946 he was in the Technical Branch of the R.A.F., where he worked mainly on automatic equipment for gunsighting and on rockets. He joined the staff of the Engineering Dept., Cambridge University, in 1947. In the academic year 1950-51 he was Visiting Assistant Professor at the Massachusetts Institute of Technology; he is a member of the American Society of Mechanical Engineers and of the Society of Instrument Technology, and has lectured on aspects of automatic control at the Universities of Minnesota and Pennsylvania and to the American and Royal Dutch Societies of Engineers. He has also spoken on the subject of automation in the BBC program "Talking About Science", and in 1955 gave a series of popular lectures at the Royal Institution. The author's previous book, Theory of Control, was published by the Cambridge University Press in 1951.

Multiple Loops

It is not surprising that human reactions are so complex, quite apart from their nonlinearity, when one takes into account the amazingly complicated system of interrelated control loops from which the nervous system is formed. Analysis is difficult enough when only two automatic control systems are similarly linked. This happens, for example, when we wish to control both the humidity of the air in a house and its temperature. We cannot treat this as two separate problems, for making the air moist may also alter its temperature, while making it warm must change its humidity. Theory indicates that it is possible for a multiple loop system of this sort to be unstable, even though each control would work satisfactorily with the other out of action. It can also happen that a multiple loop system that is normally quite stable becomes unstable when one of the variables is fixed, by external interference.

An important practical example of a multiple loop occurs in the control of a gas turbine or jet engine. The speed of rotation must be limited, or the rotor would fly to pieces, and the gas temperature must not be too high, or the material would wear out very quickly. Nor must the speed or temperature be too low to maintain the power output. But these two quantities are each dependent in a complicated way both on the fuel supply and on the size of the intake or exhaust passages, which may be made variable. This is indeed a difficult problem for the control engineer.

Even with a single loop control, the designer usually has, in practice, only a rather rough idea of the various time lags, so that he cannot expect to lay out a complete new scheme from theory alone. Analysis is none the less important for several reasons — calculations enable the designer to decide which factors it is most profitable to adjust to improve the performance and, furthermore, he can obtain from his equations some indication of the best performance which is attainable. Theory can accordingly provide him not only with a guide for his early designs, but also with a goal at which to aim. It may thus help to estimate what degree of refinement is economically desirable.

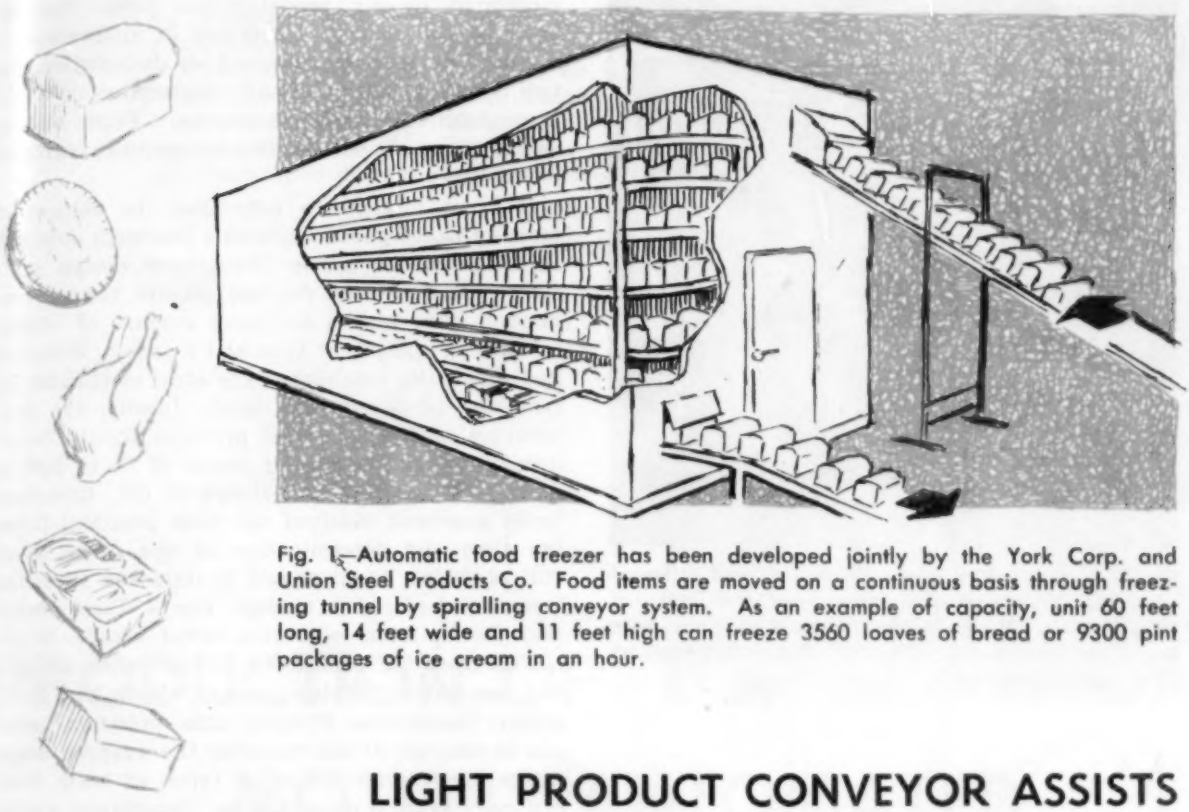


Fig. 1—Automatic food freezer has been developed jointly by the York Corp. and Union Steel Products Co. Food items are moved on a continuous basis through freezing tunnel by spiralling conveyor system. As an example of capacity, unit 60 feet long, 14 feet wide and 11 feet high can freeze 3560 loaves of bread or 9300 pint packages of ice cream in an hour.

LIGHT PRODUCT CONVEYOR ASSISTS

CONTINUOUS FOOD FREEZING

UPGRADING batch-type operations to continuous production processes is a modern cost-cutting trend which is evidenced in all types of industries. Typically, it is the use of conveyors to provide for processing while items are in transit that has upgraded batch-type freezing operations in the food industry—and in particular most recently in the bakery field.

As used by the bakery industry, controlled freezing, storing and thawing of bakery items is a unique method in achieving production economies. Normally, baked goods must be prepared for use on an as-needed basis. However, goods properly frozen immediately after baking can be stored until needed and, when thawed, suffer no deterioration of quality or appearance.

With facilities for frozen storage, in only one run during a given week, the modern bakery can produce a quantity of an item which might have required five or six separate production setups throughout the week. Considering the variety of items produced, general problems in preparing and baking different products each day, different packaging requirements, etc., it can be seen that baking for frozen storage is a considerable improvement over prior production methods. Early applications of this freezing technique involved the considerable labor of manually racking the various items and moving batches of product into and out of cold storage on hand carts.

An automatic, continuous food freezer capable of handling a variety of baked goods simultaneously has been developed by the York Corp. in co-operation with Union Steel Products Co., manufacturers of conveyors. Though developed for the baking industry, the continuous freezer is applicable to the freezing of food products such as poultry, packaged meats, ice cream and other bulk items. Basically, the automatic freezer consists of a conveyor system which transports the product into a freezing tunnel, then moves it steadily through the tunnel until the proper freezing temperature of the item is achieved, *Fig.* 1. The frozen food is then transported to a holding room. Variations in capacity, freezing times, conveyor widths and speeds, etc. can be engineered to meet the demands of various food industries.

The conveyor consists of self powered, synchronized sections of steel wire belting which move on nylon bearing strips mounted on formed channels, *Fig.* 2. The linked steel wire belting allows complete circulation of air around all products and provides a clean sanitary surface so important to food industries. This is the same type of light

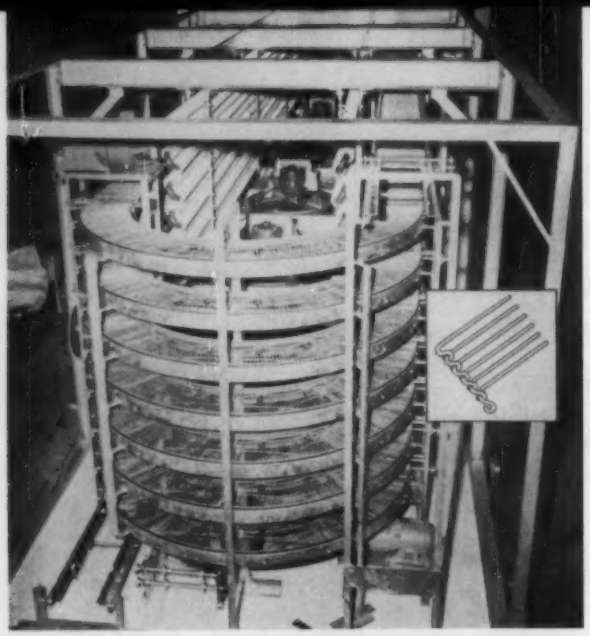


Fig. 2—Freezer unit, with outer walls and roof of tunnel removed, shows conveyor system, fans and banks of freezing coils. Sketch indicates method of joining wire lengths to form conveyor belting. Conveyor travels on nylon guides mounted on formed channels.

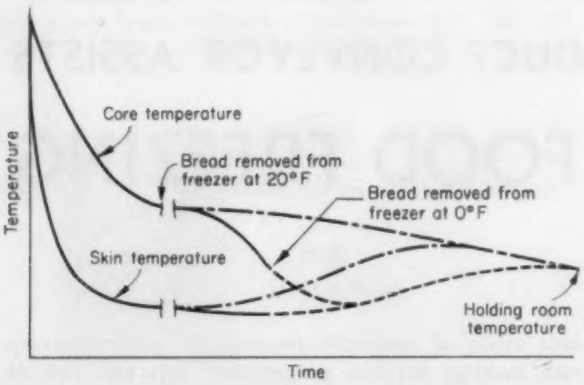


Fig. 3—Graph compares effects of cooling core of loaf of bread to 20F and placing in 0F storage against cooling core to 0F and placing in storage. Basic purpose of freezer is to reduce temperature through critical 65 to 20F range as rapidly as is possible. Little is accomplished by using freezer capacity to reduce bread to temperature which it will eventually assume in storage. Hence, bread is removed from freezer after core has reached 20F.

product conveyor that has found application in various phases of handling in the food industry.

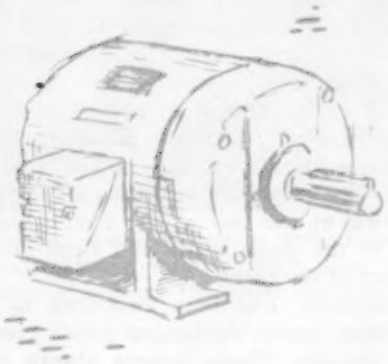
A compound compression system is used to produce the low temperature refrigeration required. The system is made up of necessary controls, a rotary and a reciprocating compressor. Freon gas vaporized in the cooling cycle is removed from a receiver by the rotary compressor and pumped through an inter-stage cooler to the second stage reciprocating compressor. High pressure gas is condensed in a water cooled condenser and flows into the receiver where it is pumped through the coils. A coil bank is placed along either side of the conveyor in the freezing tunnel and air is circulated by six propeller-type fans. Temperature of the coils is maintained at approximately −40F. The specially designed air distribution system results in a uniform air temperature of −30F throughout the entire enclosure. From end to end and top to bottom the temperature variance is less than 2F.

It is of interest to note that the subject of freezing baked goods required a thorough objective investigation to insure the proper design of a freezer which would fit into present bakery production lines with a minimum amount of change in existing equipment type and location. Research had previously established the ideal conditions for freezing and storing of bread. Ideally, the temperature of freshly baked products should be reduced through the staling range of 65 to 20F as quickly as possible and stored at 0F. Questions to be answered involved the most practical freezing time and determination of the point below 20F at which bread should be removed from the freezer and placed in storage, *Fig.* 3. Tests proved that for optimum operation bread should be removed from the continuous freezer when its core had reached a 20F temperature. With the York-Union Continuous Freezer, this optimum point can be reached 90 minutes after the wrapped bread enters the freezer. Similar types of tests were run on specialty products, i.e., doughnuts, cakes, etc., to establish the feasibility of using the same freezer for these items and bread. Tests proved that there was little penalty in handling these products simultaneously on the same conveyor.

In that the main use of frozen bakery items is within the bakery itself, defrosting of the frozen product next came under study. Here, the problem is the reverse of freezing in that the temperature of the product must be raised to 65F as rapidly as possible consistent with other factors such as preventing moisture formation on the product or wrapper. Ideal conditions for defrosting were determined as being at a temperature of 100F, 50 per cent relative humidity, and with a minimum air velocity of 200 fpm in the defrosting room.

In the past, a major deterrent to the freezing of most baked goods has been the relatively high cost of freezing and storing a bulky, low-cost item. Fortunately, the advantages of a continuous system can offset, to a great extent, the cost of freezing bread on a large scale. Depending on the method of merchandising, losses from staling can be reduced or completely eliminated. Production schedules can be smoothly adapted to a five-day work week and to extended lines of distribution from a single bakery. Unexpected fluctuation in sales volume can be absorbed with little or no loss because of either goods produced in surplus or of inadequate supplies of freshly baked goods. Controlled continuous freezing insures a uniformity of product that is as equally acceptable to the customer as freshly baked goods. Baked product freezing has every indication of making baked goods a stable item rather than a perishable commodity.

Fig. 1—Blanking press shown here operates on a fully automatic cycle. Laminations produced from rolls of sheet steel are moved on for further operations via under-floor conveyors. Metal floor boards are removed to show operation. Barrymounts used under machinery provide flexibility to the automated plant layout.



PRODUCTION OF MOTORS AUTOMATED

Increased use of motors in automation installations creates need for automated facilities for motor manufacture. In this installation a manual line for special motors is integrated with automatic lines for standard models to achieve maximum utilization of high production equipment.

PLANNING ahead has resulted in many automation programs being established in American industry. Such planning is often spurred by a company's estimate of production facilities required to meet forecasts of market increases. The installation of modernized facilities has a snowballing effect on the nation's economy by creating, in turn, increased demand for production equipment and components that make up automated facilities. Illustrating this action and reaction is the modernized General Electric Co. plant at Schenectady which produces low integral horsepower induction motors for their Medium Induction Motor Dept.

Thinking for this new facility started as early as 1948. Business was booming and a survey revealed that the Tri-Clad motor was well accepted. Customer demands for new motors were becoming more complex in sizes, types and modifications which were being requested to fit in with the trend toward greater mechanization. Overall demand for these products was increasing to the point where the facilities then in use would soon become overloaded.

O. F. Vea, general manager of the Medium Induction Motor Dept., has said: "From the beginning our approach was to consider the operation as one integrated unit across all functions. The designer, the manufacturing engineer, procedure specialist, and the product planner all worked intimately together on all aspects of the plan. The plant was considered as one system or machine and an organization plan was developed to integrate with it. The keynote of the plant was automation. Here we are manufacturing motors which will serve to mechanize and automate American industry of today and tomorrow. And it is only logical that the shoemaker's son should wear shoes."

General Electric estimates that 80 per cent of the motors in use in American industry are induction motors, and that the motor market will increase in the next ten years by at least 75 per cent. Again at this point, management concern for action and reaction circumstances enters the planning. To be in a strong competitive position in an expanding market it is not enough to have only the automated production facilities necessary to

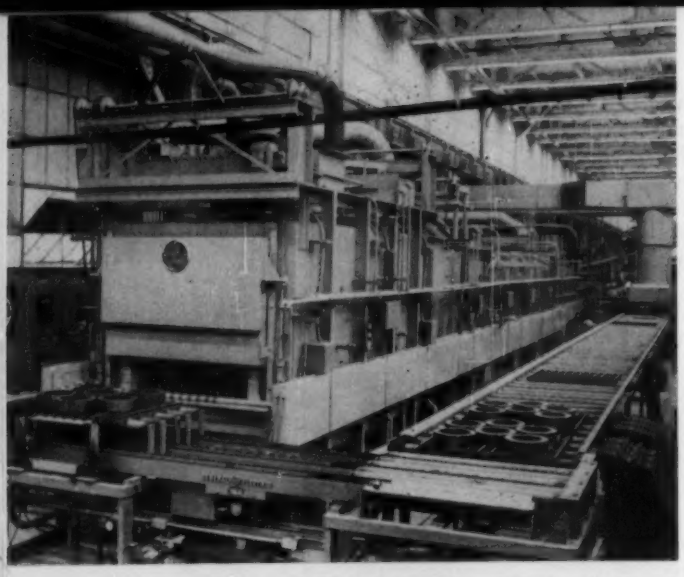


Fig. 2—At General Electric Building 85, hundreds of pounds of rotor and stator punchings are annealed every hour with one pass through this furnace.

make the product. New marketing programs had to be developed to maintain order rates that are higher and steadier than ever before. These include advertising and selling techniques designed to assure that a satisfactory per cent of the increased market potential is obtained for the company.

General Plant Layout

Layout of this new $7 million facility was made with the aid of a scale model which assisted with the early planning and served as a guide during the installation of the equipment. The plant is organized into three basic areas running the length of the building. It is, in effect, three factories in one. The two outer lines are high-volume, low-variety manufacturing facilities using flow and mechanization techniques to mass produce 100 standard motor models which comprise 60 to 70 per cent of the total business.

The center line is a low-volume, high-variety manufacturing facility which draws standard parts from the two outside lines and then modifies and alters them to turn out the other 1 million special types of motors which can be made in this plant.

This complete separation of manufacturing responsibility for standard and special motors is an important customer service aspect of the new plant. No longer do the special motors flow down the same lines as the standards to slow down the entire manufacturing process. In the high production lines on either side of the factory, the standard models are mass produced and stocks of these motors are maintained at the back of the factory. Standard models of the 7½ to 30 horsepower motors progress from stampings to finished motors in three 8-hour shifts. Formerly it took two weeks to produce these motors. The cycle of models is repeated on a biweekly schedule, each model number being manufactured every two weeks. The longest shipping cycle on a standard motor, therefore, is two weeks, and it is only this long if the factory is unable to ship from stock.

Streamlined materials handling has sharply increased production of the motors. Transfer of material to successive work stations is accomplished by roller conveyors, overhead trolley conveyors and transfer mechanisms built into certain machines. Metal scrap from the punch press operations is collected under the floor in an automatic operation conveying it to a chute which shakes the scrap into a large bucket. The cycle is concluded as the bucket fills to a pre-set load, when it automatically lifts to a position where the scrap is dumped into a collection truck outside the building. The bucket then returns again to its original position at the end of the chute. Shaking operation of the chute starts and stops at set intervals as part of the cycle.

Flexibility has been enhanced by placing all machines except the largest punch presses on movable mounts. These mounts absorb shock of operation and provide for easy removal of a machine for maintenance purposes as well as allowing for revision of the plant layout as further refinements of the manufacturing technique are developed.

Each layout for standard model production has a main line which starts with the punching of rotor and stator laminations, splits into parallel lines for the manufacture of completed rotors and stators and is joined by branch lines that machine rotor shafts, stator frames, end shields, and connection boxes. All branches come into the main line before it reaches the final assembly and test stations. The finished motors are then boxed and stored

Automated Process

One of the standard lines will be used to illustrate the steps of the manufacturing process. This line manufactures 40 standard models of motors

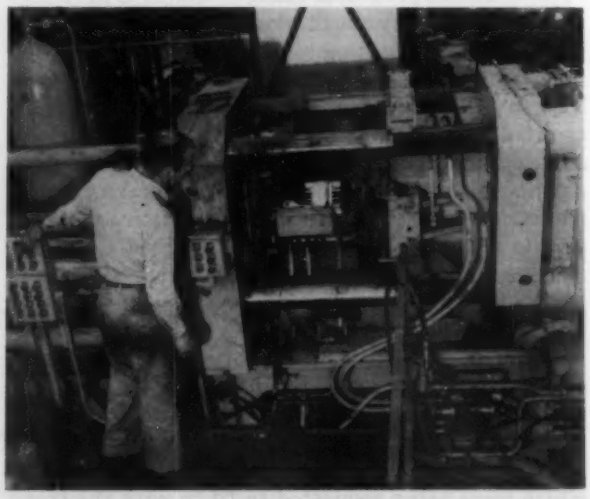


Fig. 3—A molten aluminum alloy, heated to more than 1,000°F, is pressure-cast into the rotor core in a process which prevents air pockets from forming in the core. Internal fan fins are cast as one piece with the rotor for extra strength.

Fig. 4—End shields are machined at several stations. New design of tooling and equipment helps assure better alignment of bearings for longer motor life.

all in the NEMA 254U and 256U frames. Having motor frames of only one diameter to contend with greatly simplifies the problem of mechanizing certain operations.

In the punch press area, seven presses are linked together in an almost completely automatic operation that produces stator and rotor laminations for these NEMA 250 size motors. The blanking press is fed continuously from coiled steel stock. Under-the-floor conveyors move the material from one press to the other, *Fig.* 1, and an under-the-floor conveyor system automatically removes all the scrap from the area. In this area is achieved what is perhaps the highest degree of mechanization in the plant.

The original blank has an outside diameter of the size required for the stator and an inside diameter as required for the rotor. The second press operation blanks out a rotor and stator lamination from this original blank and sends each on its way in separate conveying systems. Stator blanks are subsequently notched by a press setup using one hit per blank, while rotor laminations are notched on V & O press setups that automatically index and make one notch per hit.

From the press area, stacks of punchings move by gravity-fed conveyor to a welding area where stator laminations are welded into the motor's magnetic core. A welding machine puts 12 welds on the outside perimeter of the stator core automatically. The stator core then passes through an annealing furnace, *Fig.* 2, and into a winding area, where the motor windings are inserted. Winding is an operation that has not yet been mechanized, and it is here that the highest amount of direct labor in the factory is employed.

After winding, the motor core passes through a varnishing and baking operation. The core is placed on a moving conveyor, and three varnishing and baking cycles are applied automatically without further handling on the part of the operator.

The stator core is swung like a pendulum after emerging from the varnish bath, to insure an even flow of varnish throughout the windings. The stator cores then travel down conveyors to a station where they are pressed into the motor frame.

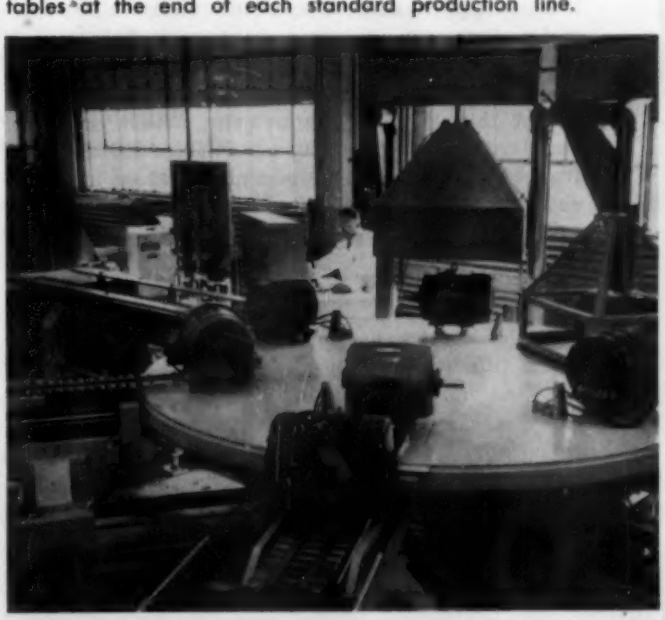
The cast iron stator frames of the Tri-Clad "55" motors are machined on a Natco multi-station boring, tapping, and drilling machine. This is a fully automatic transfer type machine. The frame emerges completely machined and cleaned. After the stator core is pressed into the frame, this part of the motor travels to the assembly area.

The rotor punchings meanwhile have been passed through a core plating operation where they receive a coating of special varnish which improves the electrical properties of the rotor. From the core plate bath, the rotor punchings are put in a die-casting machine, *Fig.* 3, where the rotor bars, end rings, and fan are cast as one piece of aluminum. From the casting machine, the completed rotor cores travel on an overhead conveyor to the final assembly area.

On a branch line, shafts are machined on automatic lathes, and they, too, travel from here to the final assembly area. Four machines perform all the drilling, boring and tapping operations required on the end shields, *Fig.* 4, and the finished end shields travel on to the assembly area, where the mass produced parts are assembled into completed motors. To assist in the assembly, there is a lineup of transfer mechanisms and holding devices that assures true motor alignment and speeds the assembly operation.

From the assembly area the motors pass on to an automatic test stand, *Fig.* 5. Here, in two stations, the motor is automatically tested and checked for noise, vibration, and quality of insulation. If the motor fails to meet the standards of any one of these tests, it is automatically rejected by the test machine and does not pass down the final

Fig. 5—All Tri-Clad motors receive running, sound and electrical characteristics tests automatically on rotating tables at the end of each standard production line.



assembly line to painting, boxing and shipping.

At the end of the line a supply of motors is stored to meet fluctuating customer demands. In this stock rack, motors are loaded into the rear of the rack, roll to the front by gravity and are removed as needed. This gives automatic turnover of the stock.

In addition to the speed achieved on this manufacturing line, real improvements have been realized in quality control. Besides being inspected on the automatic test stand after assembly, each of the motor parts is carefully checked and tested in the area where it is manufactured.

For example, the stator cores are tested for magnetic properties after annealing, before the electrical windings are applied. After the windings have been inserted, the wound stators receive a high-potential test. If they fail here, they never have a chance to get assembled into a motor.

Each rotor is tested for dynamic balance. All machined parts, stator, frames, and endshields, must pass tests and be within close tolerances before they reach the final assembly area.

In addition to this, engineers periodically select random completed motors, tear them down, and give them complete mechanical and electrical inspections. In a mechanized modern motor plant like this it is possible to maintain increased high quality standards.

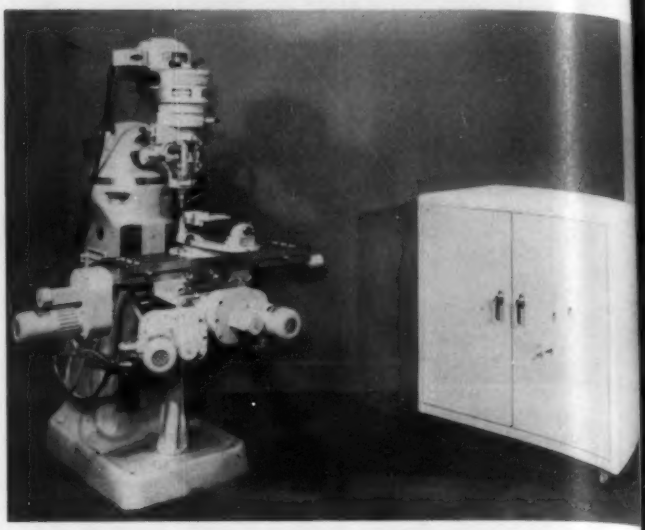
While the standard lines are turning out high-volume models, the special line is engaged in the business of serving special customer needs. Whatever anyone wants in the way of special shafts, special voltage, special insulation, or any other special motor feature or accessory, is built for him on the center manufacturing line. As a result of this line the production rate on special motors has been more than doubled, and shipping cycles have been reduced from 8-12 weeks down to 3-6 weeks.

The special line operation draws as many standard components as possible from the highly mechanized standard motor lines. This not only prevents duplication of machines in the factory, but it also helps to achieve minimum costs on the special motors.

The third line, on the opposite side of the factory, is another standard manufacturing facility, except that it is set up to manufacture some 60 standard model motors in the NEMA 280 and 320 frame diameters. Its method of operation and machining is similar to that of the 250 diameter line.

For the Future

In speaking of this automated production facility, J. R. Olin its superintendent says: "Here in our Tri-Clad "55" motor plant we have seen our long-range dreams come true. We have built a plant with capacity for the future. We have built flexibility to meet changing customer requirements for various motor types. We have achieved the ultimate in mechanization for the kinds of motors we are making. And we have realized new standards of employee comfort and morale."



TAPE CONTROL SYSTEM

ONE OF THE DIFFICULTIES presented in tape controlled machines is the great complication caused by the attempt to provide complete versatility. The desire to reproduce any continuous trace from a minimum of plotted points has resulted in computing problems in which digital information requires analog conversion with considerable complexity of manipulation.

Electronic Control Systems Inc., has avoided this complexity of equipment by utilizing pulsed signals on magnetic tape in a Digimatic system which produces servo commands for machining straight lines and circular arcs (not just chord approximations). However, higher order curves can be produced by special design of the computer unit. The Digimatic system operates on digital input, and in its basic form provides for control of a large percentage of the operations normally required of vertical milling machines.

Digimatic consists of two principal units—a planning desk, the main part of which is a high-speed decimal computer and tape recorder, and a machine control unit which governs the operation of a machine tool by the instructions on the magnetic tape. To prepare a typical precision cam

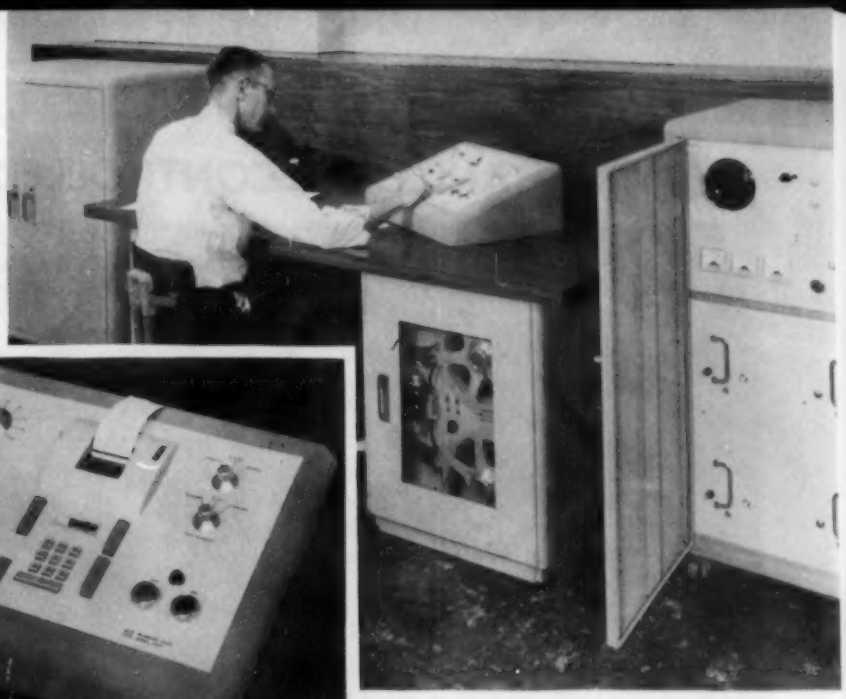


Fig. 1—Vertical milling machine and Digimatic electronic control unit. Numerical instructions, automatically computed by the planning desk and recorded on magnetic tape, control operation of the milling machine.

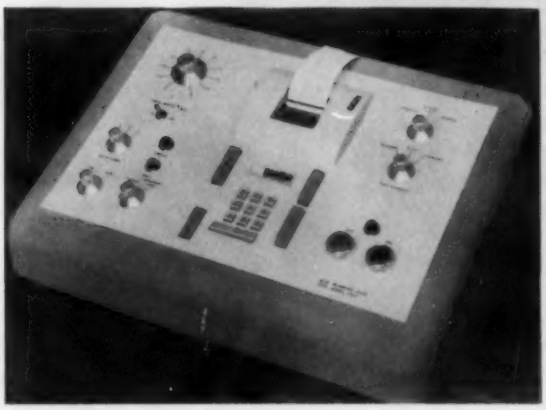


Fig. 2—Operator entering dimensions of part to be produced into Digimatic planning desk. Computer in cabinet, at left, interpolates dimensional information into pulse signals which are recorded on magnetic tape. Cabinet at right contains power supply for all units of planning desk.

FEATURES SIMPLIFIED PROGRAMMING

for machining from a metal blank with a magnetic tape controlled vertical milling machine, the dimensions of the finished part are first fed into the planning desk in sequence, *Fig.* 1, through a keyboard similar to that of an adding machine. After each dimension is entered into the keyboard, the operator presses a button marked *Compute,* signaling the computer to take that dimensional data and convert it into the proper numerical instructions, which it simultaneously records in pulse form on the magnetic tape.

While each computation is in progress—a matter of less than a minute for most dimensions—an indicator lamp is lighted on the keyboard, letting the operator know that he should wait before entering further instructions. When the computer is ready for the next dimension a *Ready* lamp is lighted.

The computer not only converts the dimensional information into the correct number of electrical pulses, but it also checks itself, and will flash a warning light if an error is made. This is done by counting the number of pulses, making sure that they corresponded to each original dimension entered into the keyboard.

After all the instructions have been computed and recorded on the magnetic tape, the tape is rewound before being played back to the machine control unit. A machinist clamps the blank in the fixture, and inserts a tool in the spindle. From then on, servomotors on the milling machine, *Fig.* 2, obeying the tape-recorded instructions, move the machine's work table back and forth, and up and down, until the part is completed as shown on the original blueprint. The present Digimatic is accurate to within one thousandth of an inch, but finer tolerances can be provided if required.

One of the advantages of Digimatic over other numerical control devices with which it might be compared is its simplicity. Any competent machinist who can read a blueprint can learn to program the operation of the device with little extra training. In actual machine shop operation, since preparation of a tape of recorded instructions would be required only when a new part is to be produced, one Digimatic planning desk would serve as many as five, or even more, machine control units. Furthermore, because of the closed loop design applied to the self-checking feature of Digimatic, pieces produced have close uniformity.

MECHANICALLY CONTROLLED AIR POWER AUTOMATES FORGING OPERATION

A UNIQUE HANDLING MACHINE enables standard furnace and roll forging equipment to automatically preheat and point the ends of coil spring blanks at a rate of 618 pieces per hour. The machine, *Fig.* 1 was developed by Expert Automation Machine Co. to handle steel rods ¾-inch in diameter and 12 feet long. This machine receives bundles of rod stock from a cradle, feeds one end of each rod at a controlled rate through a slotted furnace that heats the end to 1900F, and reciprocates the heated ends in and out of forging rolls and squeezing dies. The piece is then marked with its part number by a coining die and the rods are delivered to a chain conveyor on which they are cooled and dropped into a second cradle for conveying to the spring coiler.

All actions of the rod handling unit are either operated or controlled by the operation of the forging press. The single human operator must regulate only the incoming and outgoing cradle conveyors. A control console mechanically driven by the forging press has cam operated valves that sequence all air cylinder functions. Seven revolutions of the roll forging press complete a cycle and produce a pointed and marked rod.

How It Operates

The cradle which brings the bundles of rods from the stockroom to the machine is mounted on a conveyor dolly. Two hydraulic cylinders dump the load of rods from the cradle onto an inclined ramp down which they move under control of a chain conveyor arrangement. An air cylinder controlled selector plate mechanism feeds one rod at a time from the ramp to a rotary feed device. Operation of the hydraulic dump cylinders and the selector plate mechanism are controlled by the amount of rod stock on the inclined ramp.

Motions of the rotary feed device are synchronized with twin helicoidal screws which convey the rod ends through the heating furnace. Timing of the rotary feeder to the screws is such that it delivers one rod in each axial thread space of the screws. The screw conveyor feeds the rods at a controlled rate for proper heating.

Rods are passed from the screw conveyor to the reciprocating mechanism by an air cylinder actuated feeding device. They are positioned on the reciprocating mechanism by an air operated paddle mounted on the roll forging press and are clamped in place by another air cylinder. Reciprocation of the rod is then accomplished by still another air cylinder.

Part of the basis for the high speed operation of this forging installation was the positioning of the forging press squeeze dies directly in front of and in line with the forging rolls. This makes it possible to perform the desired rolling and squeezing operations by merely reciprocating the rod. In the pointing process the rod end is fed into the forging rolls then retracted to a stationary position where the end is squeezed by the air cylinder controlled squeezing die. These steps are repeated three times. In a final squeezing operation, the rod end is lifted in the squeezing die position by an auxiliary air cylinder to a die section which coins the part number in the piece when the squeeze dies close.

From the reciprocating mechanism the rods are deposited on a chain type cooling conveyor by an air motor operated rotary cam mechanism. The cooling conveyor dumps the rods into another cradle which is conveyed to the spring coiling machine when the cradle is sufficiently loaded.

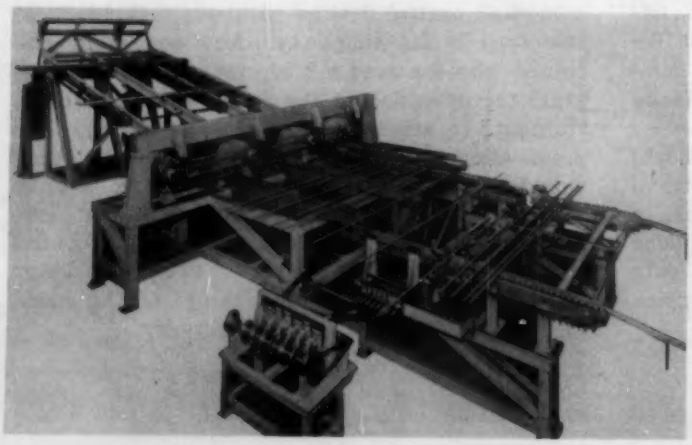


Fig. 1—Bars for automobile coil springs are pointed on one end before they are coiled. This handling machine automatically passes one end of each coil spring blank through a heating furnace and reciprocates it in and out of forging dies and a marking die.

Fig. 1—Packages traveling on the main conveyor at left are automatically discharged to selected storage and processing lines at center. The items are pushed from the main conveyor by discharge blades which travel on the bridge structures across the main conveyor.

MAGNETIC MEMORY CONTROLS DISTRIBUTION CONVEYOR

By DONALD C. MULLER and S. M. ALDER

Chief Design Engineer
A. J. Bayer Co.
Los Angeles, Calif.

Sales Engineer
Minnesota Mining & Mfg. Co.
St. Paul, Minn.

Selective distribution of discrete items from a single incoming stream to several points for processing or storage is a common problem. The authors describe an efficient solution by which handling actions are performed in accordance with recorded instructions.

SAVINGS of more than $100,000 per year are reported for conveyor systems with magnetic tape memories which have been installed at Air Force supply depots over the country. Reduction from 40 hours to 4 or 5 hours is reported for the time necessary to handle a typical distribution job. Labeled ASSET — automatic selected station electronic timer — the magnetic tape units have been developed and installed by the A. J. Bayer Co., manufacturers of conveyor systems.

At present, ASSET units have been installed only in Air Force supply depots, but some 35 units are in operation at seven different bases. Longest conveyor systems operated by ASSET to date are 500 and 750-foot systems at Hill Air Force Supply Depot, Ogden, Utah. Since the system automatically shunts packages, cartons, boxes or crates from a main conveyor line to selected stations or branch conveyors, commercial applications foreseen include distribution warehouses, mail order

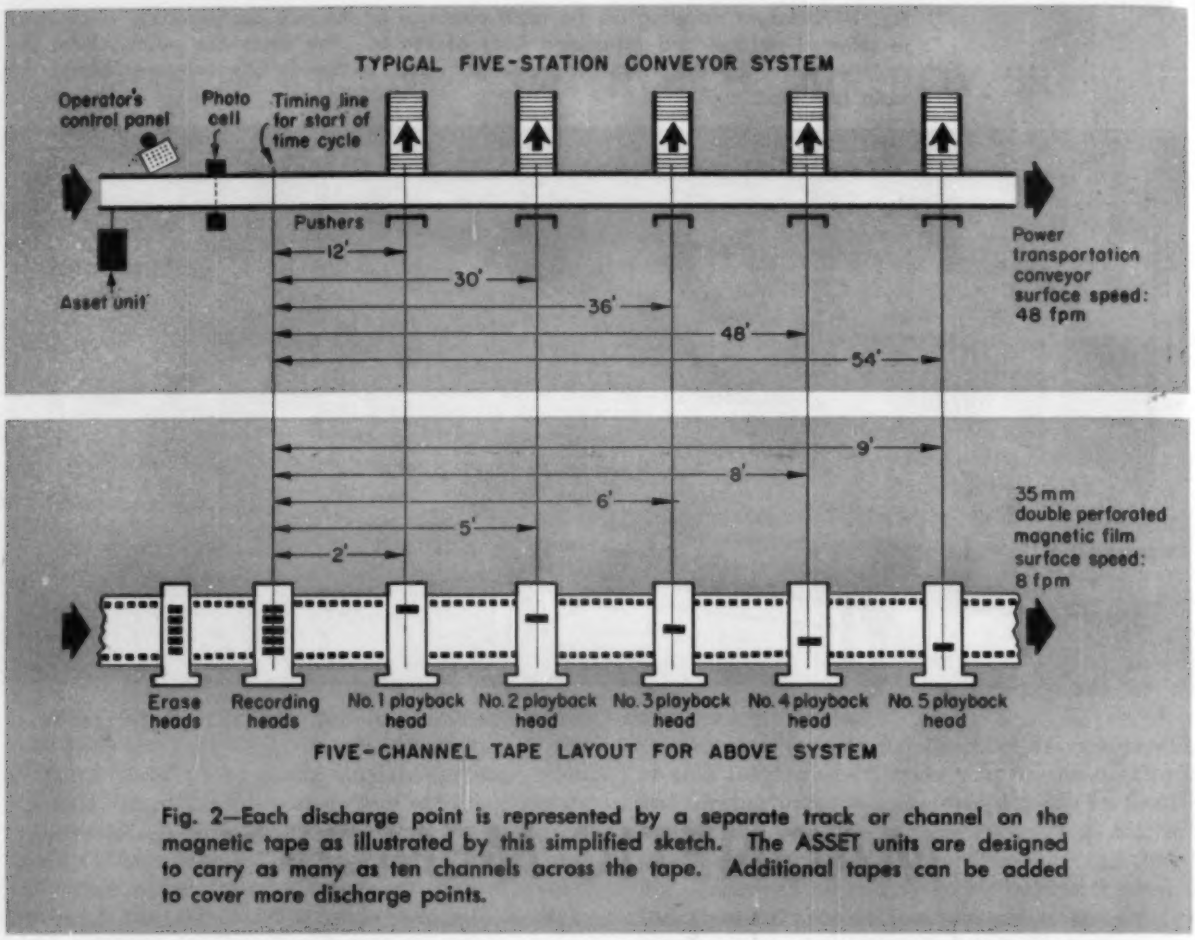


Fig. 2—Each discharge point is represented by a separate track or channel on the magnetic tape as illustrated by this simplified sketch. The ASSET units are designed to carry as many as ten channels across the tape. Additional tapes can be added to cover more discharge points.

houses, freight terminals, mail handling and other handling operations.

A main conveyor, *Fig.* 1, can carry incoming boxes down one side of a warehouse past various bays and storage areas for different types of goods. At each bay a shorter discharge conveyor may branch off from the main conveyor. The magnetic tape system makes it possible for a single operator at the loading end of the main conveyor to note the type of goods contained in each package as it approaches, decide to which warehouse area it should go, and then push a selector button for that particular discharge point.

How It Works

Basically the system incorporates a magnetic tape scale model of the actual conveyor layout, *Fig.* 2. Representing the endless belt-type main conveyor is an endless loop of magnetic tape — 35 mm wide, double-perforated, magnetic film made by Minnesota Mining & Mfg. Co. Conveyor and tape are locked in synchronization, but the tape speed is geared down 6-to-1 so that the conveyor speed of 48 fpm is represented by a tape speed of only 8 fpm. As a result, a distance of 6 feet on the conveyor is represented by 1 foot on the tape.

Distance on the conveyor from the timing point to the farthest pusher determines the length of tape. To save space on the tape panel, the tape is wormed back and forth over rollers. An impulse recorded on the tape represents a package placed on the conveyor, while a discharge point a specific distance down the main conveyor is represented in the tape unit by a playback, or pickup, head mounted a proportionate distance down the tape path from the record head.

To enable the system to handle several discharge points, five recording heads are lined up across the 35 mm tape. Each discharge point has an associated recording head, and each of the five heads has its own track, or channel, along the tape, with an unrecorded space between the parallel tracks. Corresponding playback heads for each discharge point are mounted in the respective channels at the correct distance from the recording heads. For example, if the first discharge point is 12 feet from the timing point, the first playback head will be located 2 feet down the tape path from the row of record heads. If the second discharge point is 24 feet from the timing point, the playback head in the second channel will be 4 feet from the record heads, and so on, maintaining the 6-to-1 ratio.

If more than five discharge points are to be handled, a second bank of five recording heads is mounted at a second position across the tape. This bank is slightly offset, so the heads record in the

Fig. 3—Point of package discharge is selected by this operator near the head of the main conveyor. He presses a button for the desired discharge as the package passes him on the conveyor.

spaces between the first five channels, and the ten channels interlace. If more than ten stations are to be handled, a second or third tape layout is added to the panel to provide the additional discharge points.

▸ Operating Steps

Sequence of the events that take place is as follows. The operator for the ASSET unit is stationed near the head of the main conveyor at a pedestal-mounted control station equipped with a series of selector pushbuttons — one button for each discharge point or station along the main conveyor. When the operator decides the area of the warehouse or system to which a particular package should go, *Fig.* 3, he pushes a selector button on his control panel for that discharge station. This energizes the recording head in the tape channel for that point.

The control unit goes into action when the moving package interrupts the beam of a photoelectric cell at the side of the conveyor near the operator, *Fig.* 4. It then takes over with its magnetic tape memory and automatically discharges each package at the appropriate point down the line, precisely centering each package at its discharge station, and requiring no attention from the operator other than initially pushing the correct button.

A centering device finds the exact centerline of the package along its axis of travel regardless of its length, and an impulse is automatically recorded in the selected channel on the tape when the package center reaches a fixed point on the conveyor called the timing line. As the package progresses down the main conveyor toward its discharge point, the impulse on the tape moves toward its playback head. When the latter arrives, it trips a relay operating a pneumatic-powered pusher that sweeps the package — which is at that instant centered at its discharge point — off the main conveyor. Reason for centering is that it is important that the automatic pusher at the discharge station contact the package at its center. Otherwise a long package might fall when pushed from the main conveyor.

Selector buttons in this unit contain an integral pilot light which is illuminated when the button is pushed, thereby enabling the operator to verify his choice and to correct an error, if necessary, by means of a *Cancellation* switch provided for that purpose. The manipulation of one button automatically prevents the operation of any other button until the first timing sequence has been completed. There is a *Repeat* switch for automatically discharging a series or train of packages at the same discharge station without pushing the selector button each time.

A red warning light is included on the panel. The light goes on when the package cuts the photo-

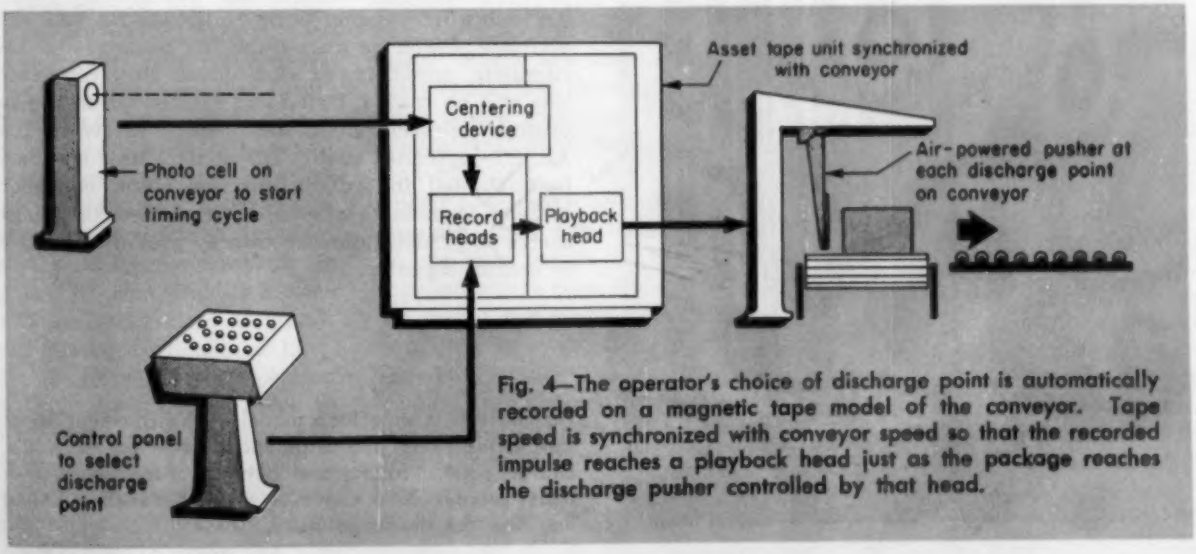

Asset tape unit synchronized with conveyor
Centering device
Photo cell on conveyor to start timing cycle
Record heads
Playback head
Air-powered pusher at each discharge point on conveyor
Control panel to select discharge point

Fig. 4—The operator's choice of discharge point is automatically recorded on a magnetic tape model of the conveyor. Tape speed is synchronized with conveyor speed so that the recorded impulse reaches a playback head just as the package reaches the discharge pusher controlled by that head.

electric beam, and stays on until the signal is recorded on the tape and the relays have returned to normal. This serves as a guide to proper spacing of packages on the conveyor, since the operator is instructed to wait for the warning light to go off before allowing another package to cut the photoelectric beam. Should the operator fail to wait, and the beam be cut while the red light is on, the conveyor stops automatically, and the operator must retrieve the package by hand, pull it back from the beam, and then restart the conveyor.

Spacing of packages is important to give the pushers, or discharge blades, time to push a package across the main conveyor onto the discharge conveyor or platform and then return. This requires approximately 3 seconds, and at a conveyor speed of 48 feet per minute, packages should be at least 3 feet apart.

Design Considerations

One of the chief reasons for using magnetic tape as the control medium is the precise control possible — especially important for centering packages of various lengths. By using double-perforated 35 mm magnetic film rather than conventional quarter-inch magnetic tape, exact synchronization is possible. Tape and conveyor are always in phase and any possibility of slippage is eliminated.

Compactness of the tape system, *Fig.* 5, is also an important feature, and further reduction in size is possible through slower tape speeds — especially where long conveyors are involved. The present tape speed of 8 feet per minute or 1.6 inch per second is completely adequate although slower than speeds used in most audio recording or other impulse recording applications. Tape speed may range from one to three inches per second.

Frequency response, signal-to-noise ratio, and other usual considerations in magnetic recording applications are of no concern here, since the problem is simply to record an impulse on the tape, sense it later, and then automatically erase it when the tape completes its circuit and again comes past the record head.

Predecessor to ASSET was a mechanical unit designed and installed by the A. J. Bayer Co. for the Union Hardware Co. of Los Angeles in 1950. Instead of an electronic timing system, that unit used a system of magnets traveling on iron wheels to sequence the actuation of the pushers at each discharge conveyor.

An interim series of conveyors abandoned the mechanical principle and incorporated ¼-inch magnetic tape loops contained in accumulation cartridges. Each tape-loop was precisely cut to a specified length, proportional to the distance from the photoelectric cell at the impulse point to its particular discharge conveyor. These tapes were mounted in a cabinet, side by side, and had a common drive to insure a constant speed for each tape.

An important consideration for the future lies in the memory system possible with tape whereby more intricate conveyor systems could be controlled. Packages traveling on a main conveyor might be selectively discharged from stations along secondary conveyors to which the packages are selectively fed from the main conveyor. Also, a system may have multiple loading points at which a number of operators may record station selections.

Another possible layout features the operator at a point remote from the ASSET controlled conveyor. He may initiate the destination selection as packages are unloaded from a truck at one side of a warehouse, and although the transportation conveyors intervening between his station and the ultimate discharge unit allow the packages to accumulate, speed up, or slow down, they nevertheless will be spaced, timed and ejected according to original selection when they finally arrive at the ASSET-controlled unit. The control unit also has been applied to trolley and tow chain conveyor systems to indicate when specific carriers or trucks arrive at predetermined points by providing visible or audible signals.

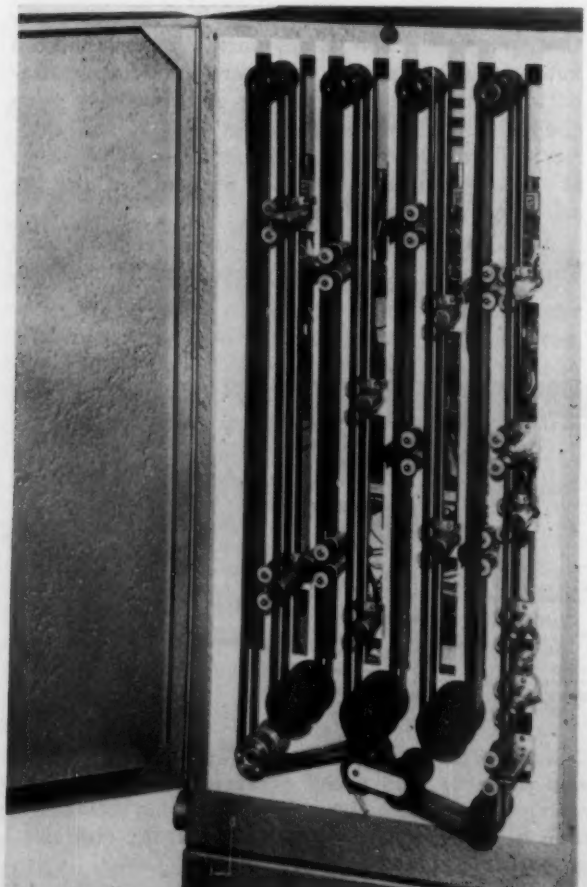


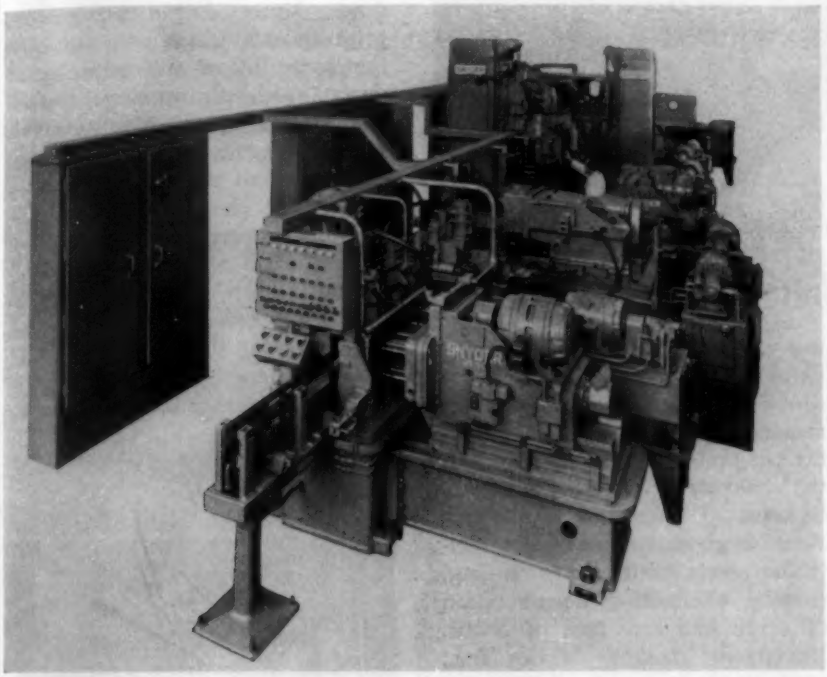
Fig. 5—Endless tape loop model of the conveyor winds past a recording and a playback head for each discharge point. Tape travel between these heads is in exact proportion to conveyor travel between a timing line and the discharge point.

AUTOMATION

new equipment

Machines and plant equipment designed for more automatic operations

For detailed information and literature, use card page 17



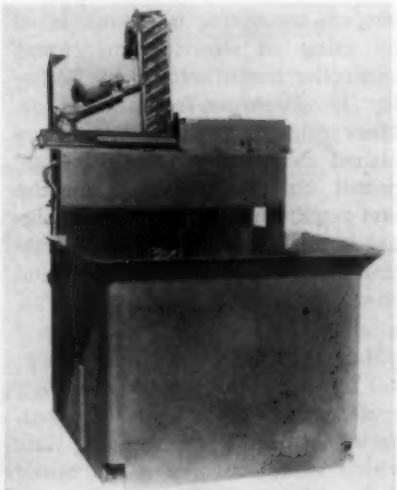
Processing and Assembly Machine

Segmented in-line transfer unit machines, gages, air tests, marks and assembles seals in cast iron automotive V-8 engine chain case covers at a rate of 108 pieces per hour at 80 per cent efficiency. New 40-station, 65-ft long machine is made up in eight segments, each having separate bases and control panels. A single transfer bar carries parts from station to station through the machine. A variety of drilling, countersinking, tapping, boring and milling operations is performed in the first five segments by an assortment of standard and special vertical and horizontal slide units. Hole inspection probes that check drilled holes to depth are provided in the third and fourth segments. If any hole is not to depth, the cycle of the next segment will not function. In the sixth segment, the chain case cover is automatically tipped 90 degrees and rotated 90 degrees to orient the part in correct location for drilling, countersinking and tapping operations in the seventh segment. Parts are then moved by the transfer bar through nine stations where they pass through a conventional wash, rinse, drain and blow-off unit. After the machined cases have been thoroughly cleansed, they are transferred to an air test fixture in the eighth segment where they are sealed and air tested for leaks. An oil seal is pressed in at the third station in segment eight. Oil seals to be pressed into the chain cover cases are stacked in vertical tube hopper feed assemblies mounted on the periphery of an index table. Controls are provided at the pressing station to assure that the unit will not function unless a seal is ready to be pressed in right side up. Upside down seals are ejected from the pressing position automatically. **Snyder Tool & Engineering Co.**, 3400 E. Lafayette Ave., Detroit 7, Mich.

Circle 401 on Inquiry Card

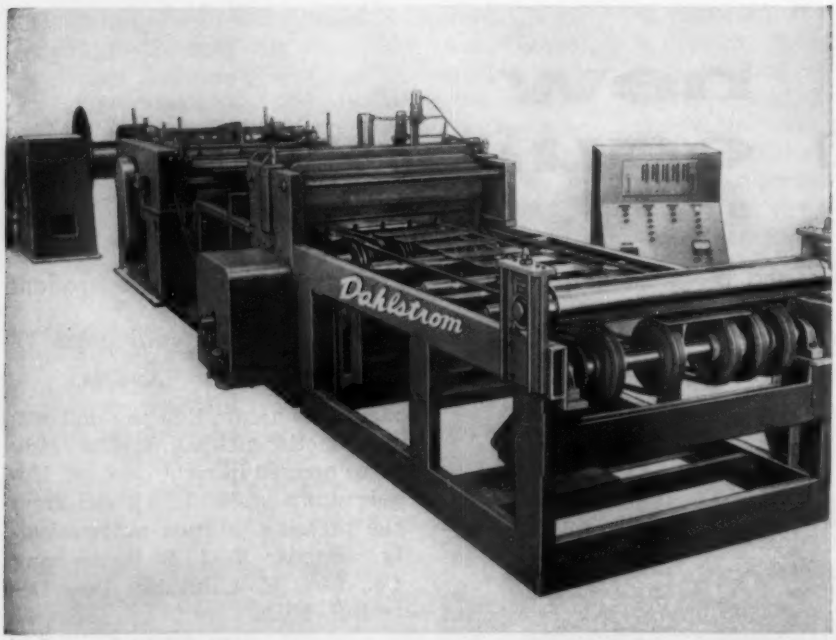
Elevating Hopper Feeder

Cylindrical parts are fed automatically with elevating hopper feeder. Designed with a 10 cu ft hopper and a 6-inch wide elevating belt, conveyor feeds, transfers and pushes slugs through an induction coil and then delivers those heated



parts to the production machine at a predetermined high rate of feed. Range of cylindrical parts is from ¼-inch diameter, ⅜ to 3 inches long, to 1½ inch diameter and 1½ to 3 inches long. Power is furnished by a ¼ hp, 220 or 440 v, three-phase motor through a variable speed drive. **Feedall Inc.**, Willoughby, O.

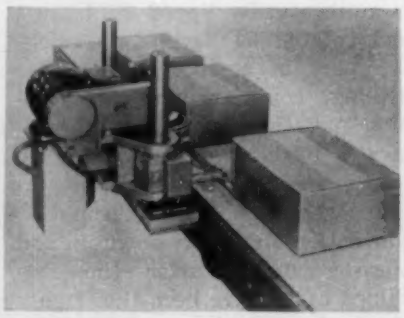
Circle 402 on Inquiry Card



Metal Surface Measuring Unit

Designed for use in decoiling and shearing lines, roll feeding lines and roll forming lines, lineal surface measuring unit provides instantaneous changeover as to length requirements, elimination of accumulated error and minimum and maximum length restrictions, and the troubles caused when running the lighter gages. Method of surface measuring is accomplished by using an electrical measuring controller manufactured by Berkeley Div., Beckman Instruments Inc. Measuring controllers are furnished as a single preset or dual preset unit, depending upon the line requirement. If only one signal is required, such as for a continuous running decoiling and shearing line or a roll forming line, a single preset counter is used which would develop the final signal for the clamping and shearing cycle. If two signals are required, such as for a roll feeding line which would involve a start and stop cycle, a dual preset counter is used. One signal would be used for the slow down action and the second signal for the final stopping action. For roll feed or decoiling and shearing lines two signals are sometimes needed when running on the hop; a dual preset counter is used and the first signal is used for slow down. In operation, the coiled material or formed section passes over and drives a measuring roll which in turn actuates an impulse generator giving out impulse signals for registration into the measuring controller. Upon reaching the preset number of impulses, the shearing or blanking unit will be actuated. Immediately after this signal is given, the measuring controller resets itself to zero reading, thereby eliminating accumulation of error and any loss of count. **Dahlstrom Machine Works Inc.,** 4227 W. Belmont Ave., Chicago, Ill.

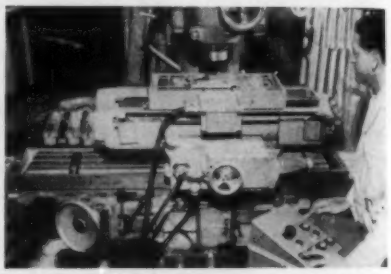
Circle 403 on Inquiry Card



Case Imprinter

Motor driven, flexographic case imprinting conveyor line unit is designed for easy attachment to a conveyor, case sealer or other handling machine where it can imprint contents identification, brands, varieties, export markings or other copy on the side of containers automatically. In addition to shipping cases, the unit is suitable for imprinting rectangular metal cans, wooden fruit crates, wire or strap bound bundles, and metal ammunition boxes. Features of the new machine are a limit switch activated electromechanism and a vertical flexographic printing system. The electromechanism controls the placement of the imprint so that it appears in the exact desired location on every container, regardless of irregular container flow. Motor driven flexographic printing unit, which uses fast drying liquid ink of any color, has a variable speed mechanism which enables it to synchronize its action with the surface speed of moving containers to make clean, sharp, nonsmudge imprints. The 750 Rolaprinter machine operates without attention at speeds up to one imprint per second, and may be quickly adjusted to accommodate containers of different size or to vary the location of the imprint. **Adolph Gottscho Inc.,** Hillside 5, N. J.

Circle 404 on Inquiry Card

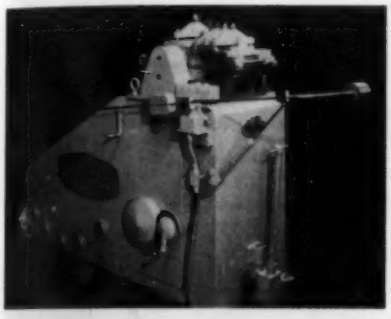


Automatic Indexing Table

Reproduction, in complex patterns, of drilling, reaming, tapping and many other operations is possible with automatic indexing table. Its use in combination with radial drills, milling machines, turret drills or other suitable spindles results in a universal production machine. An accumulator mechanism—a counter which registers table travel in inches—can be used, or a master part can be mounted on the table. Wherever a hole is indicated, an indentation is made on the tape. In production, the sensing mechanism will position the holes in the workpiece according to the indentations. Indexing speed of the machine is variable from

6 to 90 inches per minute. In operation, the table indexes rapidly, then slows down for accurate positioning. It positions to 0.001-inch. The unit is fully electric and push-button controlled. One tape controls transverse movements of the worktable and the other controls longitudinal movements. These movements are controlled electromagnetically by an electric clutch-brake which makes split second starts and stops of the lead screws as the switches sense the markings on the tapes. The unit eliminates the need for jigs, fixtures, drill bushings and other components. **Micro-Positioner Corp.**, 716 Wilshire Blvd., Santa Monica, Calif.

Circle 405 on Inquiry Card



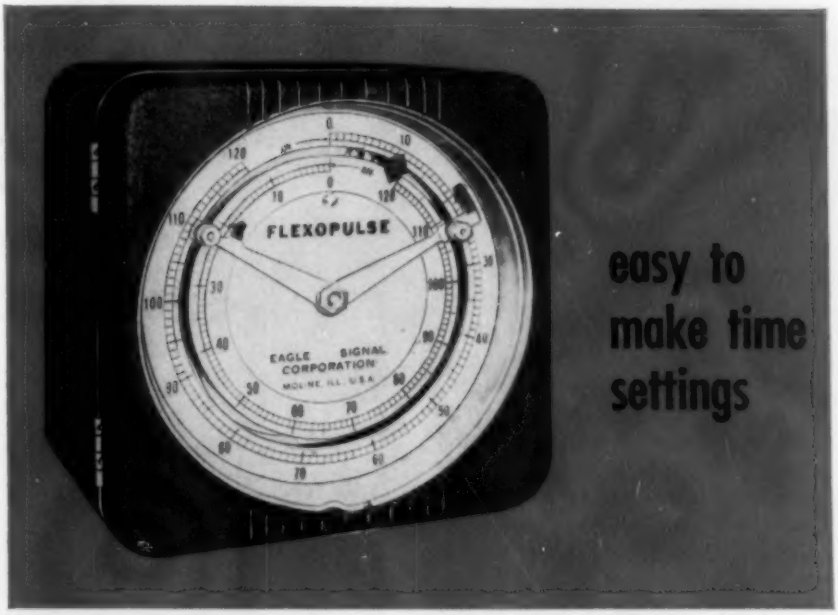
Roll Straightener Cradle

Combination coil cradle and power driven straightener model PDSC-940 handles material up to 9 inches wide and in thicknesses of 0.025 to ⅛-inch. Coils with outside diameters up to 40 inches and weight up to 1500 lb are processed on the machine. It features a cradle with five coil rest rolls mounted in self-adjustable aligning bearings. Inner side frames crank is adjustable to accommodate stock width. The straightener is equipped with six hardened and ground straightening rolls mounted in needle bearings—lower three are power driven—plus a pair of hardened and ground power driven take-in rolls. All upper straightening rolls are individually adjustable. Straightener is of hinged construction to facilitate cleaning of rolls and starting a new coil. Control mechanism is a mercury switch loop. Outputs from 49 to 197 fpm are provided by 2 hp variable speed drive. **U. S. Tool Co. Inc.**, Ampere, N. J.

Circle 406 on Inquiry Card

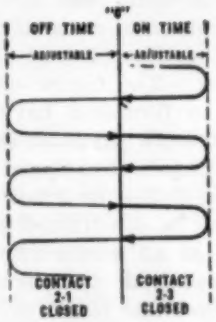
EAGLE FLEXOPULSE repeat cycle timer

WITH S.P.D.T. SWITCH



No gear change or resetting of cams required

This Flexopulse Repeat Cycle Timer is ideal for controlling processing machines requiring adjustable timed cycles. The "on" or "off" intervals are easily adjusted. Either can be adjusted without disturbing the setting of the other. Instead of resetting cams or changing gears, simply loosen two knurled nuts. Then set "on" and "off" periods by moving adjustable pointer. Tighten screws, and the job's done.



HAS CYCLE PROGRESS INDICATION:

A movable flag indicator passing over the time scale between adjustable arms, indicates portion of cycle elapsed in either of the s.p.d.t. positions. Switching operation takes place at zero.

Flexopulse is ideal for periodically operating valves to reverse the flow of liquids, for operating signals or for injecting chemicals. 120-second up to 20-hour dials are available. Synchronous motor powered. Send coupon today for free Bulletin 320.

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SIGNAL CORPORATION
Industrial Timers Division
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MOLINE, ILLINOIS

Please send free Bulletin 320 with full data on Flexopulse Repeat Cycle Timer.

NAME AND TITLE

COMPANY

ADDRESS

CITY ZONE STATE

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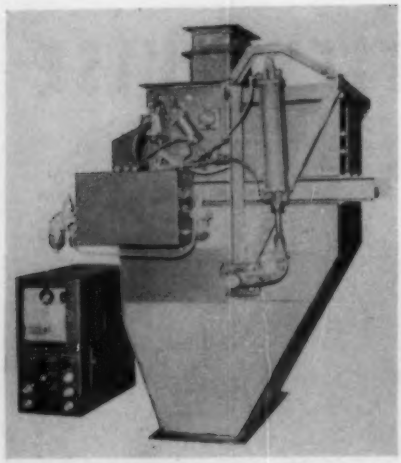
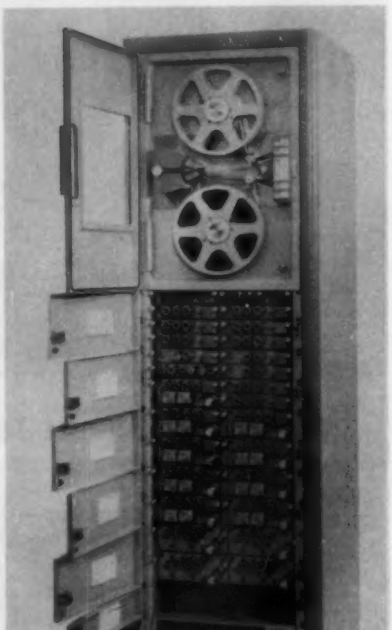


Batching Scale

Designed to handle flooding type chemicals and pulverized products, new material feeder is designated as Model 700N batching scale. The pilot model has recently completed a one-year test in a large nickel producing plant in handling and discharging nickel oxide ore to reduction furnaces. Model 700N batching scale uses a rotary type feeder for charging a gateless tipping type weigh bucket. The weigh bucket is suspended from the Thayer scale and a cycle timer controls the automatic charging and discharging of the weigh bucket. The feeder on the scale can be furnished having a rotor constructed of mild steel, Tungsten carbide steel tipped blade, neoprene, Teflon or nylon blades, or it can be constructed of stainless steel at all points which come in contact with the material being handled. The feeder is constructed so that there is no flow of product through the feeder after the weigh bucket has been properly charged. The scale is constructed having no knife-edge pivots. The scale platform, levers and weigh beam are supported by the leverage system. Scale is especially suitable when handling products which are dusty, corrosive or abrasive. Controls for the Model 700N are electrical and pneumatic. All of the electric solenoid air valves are mounted in a pneumatic control box separate from the electrical control box which can be mounted adjacent to the batching scale or can be remotely mounted in an instrument or control room. The control box is furnished with automatic checkweighing lights which will indicate the various phases of the scale weighing and discharging operation. The system is furnished with an automatic control so that if the supply of the material runs low an automatic alarm is sounded. Model 700N batching scale can be furnished in various sizes for handling from 100 lb per hour to 100 tons per hour with an average accuracy of ¼ of 1 per cent. **Thayer Scale & Engineering Corp.**, Rockland, Mass.

Circle 407 on Inquiry Card



Magnetic Recorders

Applicable in the fields of data acquisition, storage, handling, processing, analysis, and simulation, new series of modular magnetic recording components is available in models with from one to 14 tracks. The FR100 Series records and reproduces scientific data in the dc to 100,000 cps frequency range. Versatility for varying test requirements is provided by interchangeable plug-in amplifiers for direct, fm, and pwm types of recording and reproduction. Modular construction of both the electronics and the tape transport permits easy expansion of the equipment to fit user needs, allows modification for incorporation of technological advances, and reduces maintenance to a simple plug in of spare modules. Tape transports of the new series utilize a closed loop drive and a servo constant-tension device in conjunction with new tape supporting and guiding techniques to provide low flutter and dynamic interchannel time displacement errors. Six standard speeds from 1⅞ to 60 inches per second are provided. Interchangeable head assemblies, compatible with direct, fm and pwm models, mount on base plates machined to provide vertical azimuth alignment within ±1 minute of the perpendicular. All gaps fall within a band 100 microinches wide. A complete 14-track system, including transport, electronics and blower modules occupies only 73½ inches of rack space. Operation is from 117v, 60 cycle, single-phase ac. **Ampex Corp.**, Instrumentation Div., 934 Charter St., Redwood City, Calif.

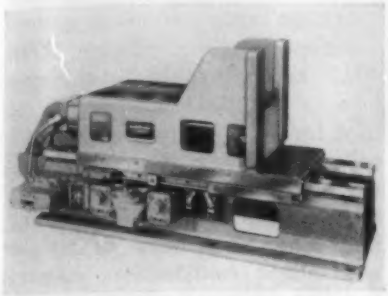
Circle 408 on Inquiry Card

Rubber Conveyor Belt

Designed to outlast conventional hot material belts by as much as 3 to 1, new rubber conveyor belt is called Solarflex. Special rubber of the belt remains pliable and elastic even when exposed for long periods to the baking action of hot materials at temperature up to 350F. Solarflex construction permits more efficient service from mechanical belt splices. Some fasteners of this type fail by tearing

out as the belt carcass hardens and cracks under the effects of heat. Both rubber and belt carcass in Solarflex retain their flexibility. New belt is available in a choice of fabric reinforcement which includes glass fabric, rayon-nylon, cotton-nylon and cotton. **B. F. Goodrich Co.,** Industrial Products Div., Akron, O.

Circle 409 on Inquiry Card



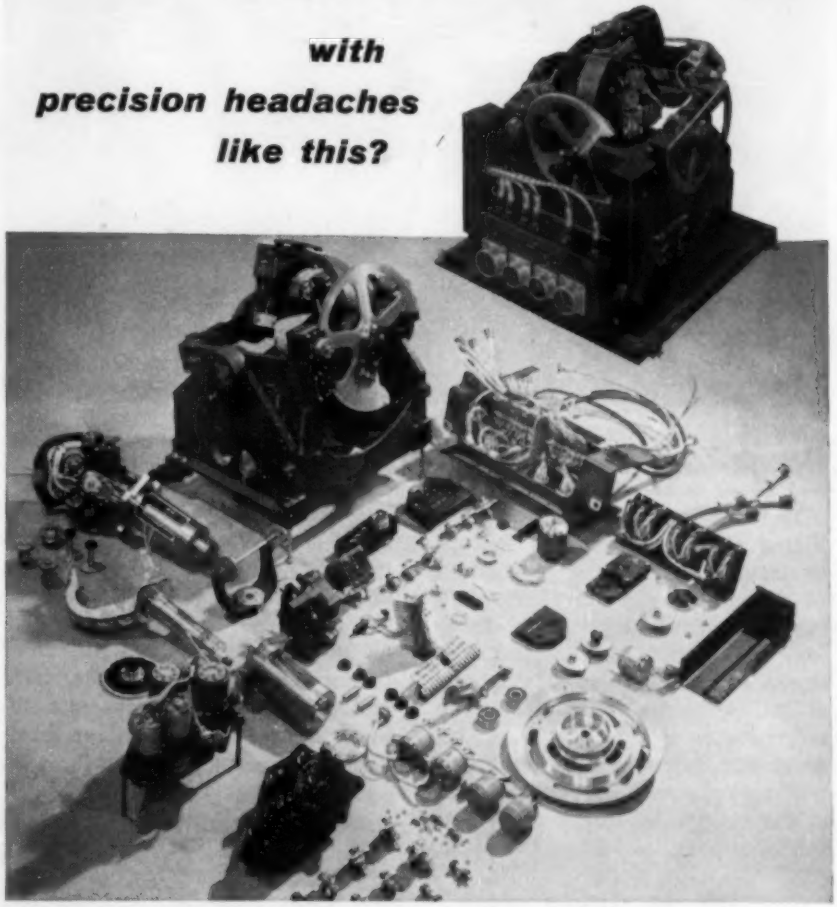
Hydraulic Feed Unit

Designed to give balanced thrust, Model 405 way-type hydraulic feed unit features thrust above the ways near the tool load. It provides positive control of rapid traverse, fine feed and depth. Depth will repeat within 0.0005-inch. Flange is designed to simplify mounting and aligning of multiple spindle heads, and the 15-inch stroke assures ample tool change clearance. In its position above the ways, the power cylinder is more accessible for maintenance and the hydraulic control panel can be mounted on either side of the unit. Separate floor type power pack supplies the hydraulic power in compliance with J.I.C. standards. Thrust of the unit depends on hydraulic pressure. At 1000 p.s.i. the 4-inch hydraulic cylinder of the Model 405 provides 12,000 lb. thrust. Feed rate is variable from 0 to 24 inches per minute; rapid advance is 8 inches per second and rapid return is 5 inches per second. Rapid advance and feed stroke lengths are adjustable by repositioning control dogs. Multiple spindle drive motors up to 20 hp., 1800 r.p.m., can be mounted on the saddle. Automatic lubrication of ways is available. Unit can be mounted in horizontal, angular or vertical positions. **Hartford Special Machinery Co.,** Hartford 12, Conn.

Circle 410 on Inquiry Card

Can you use help

with precision headaches like this?



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MECHANICAL DIVISION

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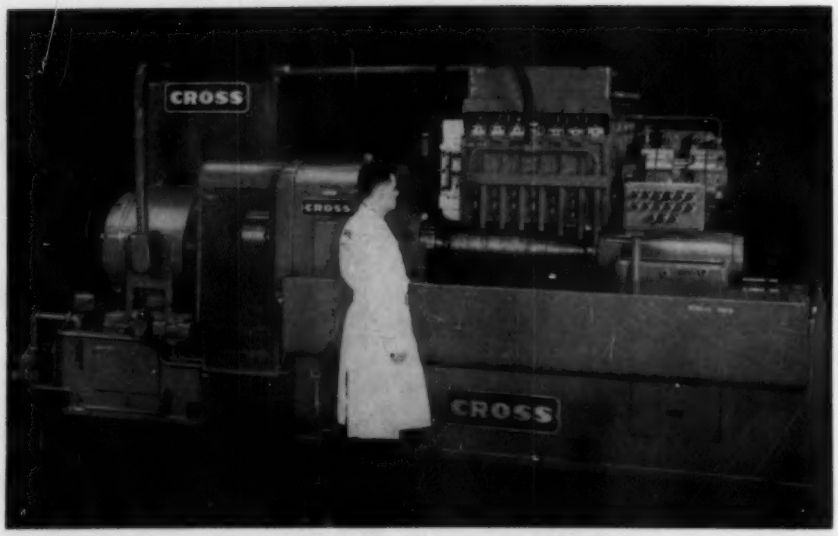
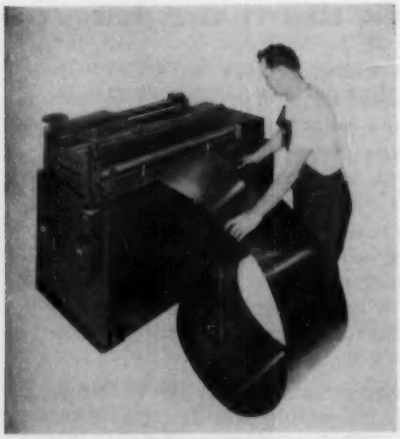


Rough-Turn Lathe for 8-Inch Shells

Loading and unloading without lifting shell is automated feature of lathe, designed for production of 8-inch shells. Machine rough turns outside diameter, finish faces and chamfers base end of the shells, producing 12 units per hour at 100 per cent efficiency. Lathe incorporates seven overhead, individually controlled, contour turning tools, and base facing and chamfering tool. Rough and semi-finish cutting is accomplished in one automatic cycle, controlled from centralized pushbutton station. Lathe has hydraulic feed and rapid traverse, hydraulic power operated tailstock and hydraulic work clamping. With preset tooling and 150 hp spindle drive motor, lathe also features an automatic lubrication system for lubricating the ways and miscellaneous points with every machine cycle. **Cross Co.**, Detroit 7, Mich.

Circle 411 on Inquiry Card



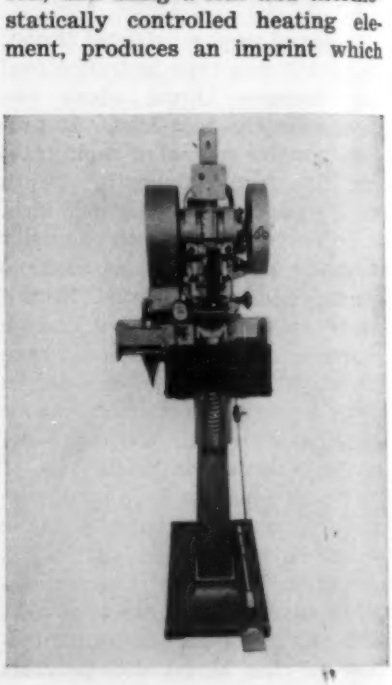
Roller-Leveler

Applicable in fabrication operations, new roller leveler flattens mild steel, hard tempered steel, stainless steel, aluminum, brass or copper, in widths up to 42 inches, and in gages from .020 to .093. The model 11-F leveler is used for straightening sheet stock, coil stock (for automatic feeds, in conjunction with punch press operations), producing cut length flat sheet from coil, and work annealing deep drawing steel. Machine operates at standard speed of 56 fpm. A single sprocket change can increase or decrease standard speed as required. Power source for the roller-leveler is a gear head, single-speed motor (or an optional variable speed drive), which is readily accessible for easy maintenance. Manually controlled reversing drum switch and motor cutout switch, with thermal overload protection, are standard equipment. All 11 straightening rolls and the two feed rolls are made of alloy steel, hardened, ground and hard chrome plated. All rolls run in roller bearings, and all except the top feed roll are power driven by a closed gear box. The bronze bearings in the gear box are constantly lubricated by oil which is retained in the box itself. All other working parts are lubricated through pressure grease fittings. **F. A. Woehr Machine Co.**, 17 Favor St., Rochester 8, N. Y.

Circle 412 on Inquiry Card

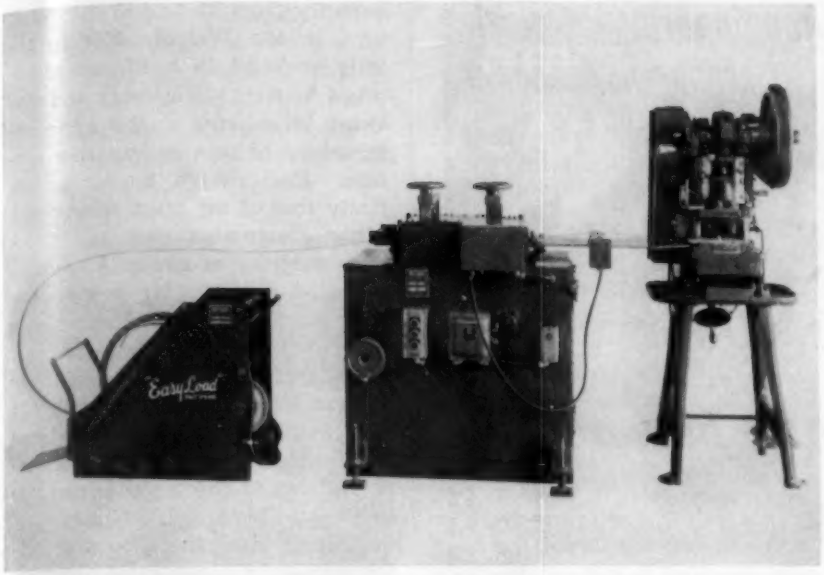
Tubing Marker

Manufacturers of electrical and electronic equipment can imprint spaghetti tubing to meet government specifications with new Model 48AI tubing marker. Polyethylene or vinyl tubing, from ¼ up to 6 inches in length is automatically fed, imprinted or coded, and cut off by new machine. The device accepts size 12 to 0 tubing, and other sizes may be handled with slight modification. Operating speed is 110 imprints per minute. The machine feeds from a coil, and using a leaf and thermostatically controlled heating element, produces an imprint which



meets government specifications. Work guides are self-adjusting for height, and are easily interchanged for various tubing sizes. The 48AI has a maximum imprint length of 3 inches, the depth being governed by tubing diameter. Cut-off knife is also adjustable to cut on print centers up to 3 inches, or may be disconnected entirely. Sliding masterplate and engraved type inserts facilitate easy legend change. **Markem Machine Co.**, Keene 55, N. H.

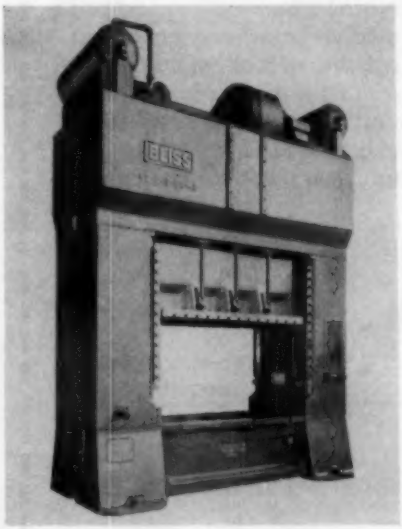
Circle 413 on Inquiry Card



Coil Cradle, Feeder and Straightener

Automatic coil cradles which range in size from the "Junior" series which has a load capacity of 200 lb and can handle aluminum foil, speaker paper and leather, to the 4000 series which handles coils weighing up to 4000 lb, and the larger than 4000 series which handles widths to 48 inches and has a capacity of 15,000 lb, with an outside diameter of the coil up to 60 inches. Coils are easily loaded into the cradle, either by hand or machine. The actuator which guides the coil as it comes out of the cradle, swings out of the way to facilitate the loading operation with a minimum of time and effort. The machines can be placed adjacent to the machine they are feeding because of their relatively small size. They provide a constant slack loop of material for feeding punch presses, forming rolls, shears and slitters. The *R* and *S* series of machines straighten and feed metal from coil stock automatically and meet the need of metal fabricators who require straightened metals in a wide range of lengths. A Warner electric clutch brake used on these machines permits the motor to run continuously. Up to 60 starts and stops per minute is one of the features of these series. Standard feed rates of the *R* series are from 18 to 95 fpm; the *S* series rates are from 20 to 105 fpm. Maximum width capacity of the *R* series is 10, 15, and 20 inches, while the width capacity of the *S* series is 10, 15, 20, 24, 30 and 36 inches. Machines can be made portable by a lift jack. **Rowe Machinery & Mfg. Co. Inc.,** 1506 N. Industrial Blvd., Dallas, Tex.

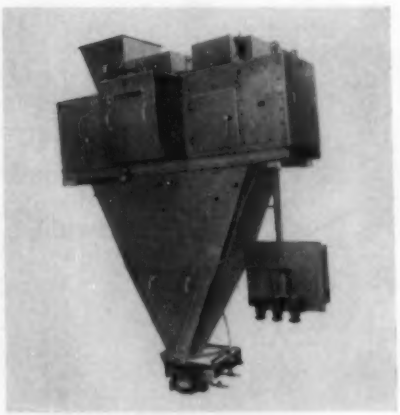
Circle 414 on Inquiry Card



Enclosed Presses

Design features of two-point enclosed press include a left-to-right gear drive, electromechanical rotary switch for automation control, built-in lights over the die area and automatic oil lubrication. Presses are designed for automated production lines by building into the uprights all of the many air and electrical lines needed for auxiliary equipment. Gear arrangement of the press utilizes twin intermediate shafts which permit mounting the flywheel, clutch and motor drive in between, making a compact drive system which is housed within a box crown that is symmetrical both right to left and front to back. As a result, the floor space required by the presses is less than that needed for enclosed presses with front-to-back drive. Presses are available in capacities ranging from 150 to 750 tons. Doors and covers which provide access to electric, air, oil and other systems are flush mounted, as are buttons, switches and other controls. Illustrated 200-ton press operates at 20 strokes per minute. **E. W. Bliss Co.,** 1375 Raff Rd., SW., Canton O.

Circle 415 on Inquiry Card



Bagging Scale

Ten or more sacks of dry aggregate are accurately proportioned and bagged by high-speed, automatic bagging scale. System proves particularly useful in the do-it-yourself dry-mix concrete market, where dry ingredients are weighed and bagged for sale to the user who has only to add water to make concrete. Called the Weighblender, the unit consists of a series of three scales mounted in a frame, with the bagging hopper beneath arranged to receive ingredients simultaneously from all three scales. This arrangement permits blending of ingredients as they enter the bag. Any three concrete ingredients, including sand, cement, gravel or lime, can be simultaneously proportioned, mixed and sacked in a single operation. The system will accommodate bags ranging in

AIRengineering at work
REPORT No. 5098B-3

Multiple Screw Driver assembles 400 carburetors per hour

Assembling carburetors was a slow, one-screw-at-a-time operation until AIR engineering solved the bottleneck. Now one operator uses this 8-spindle automatic Multiple Screw Driver to help turn out more than 6 completed carburetors per minute—400 every hour.

This compact, easy-to-operate Multiple Screw Driver is just one more example of how AIR engineering is helping modern industry solve problems and cut production time and costs.

All the experience of Ingersoll-Rand in speeding up fastening through AIR engineering multiple units is yours for the asking. Whether your operations involve screw-driving or nut running with either hand-held or automatic production line units, Ingersoll-Rand can engineer and build just the unit best suited to your needs.

8-Spindle Multiple Screw Driver for carburetor assembly.

Drop us a line if you'd like an AIR engineer to analyze and make recommendations on your fastening operations.

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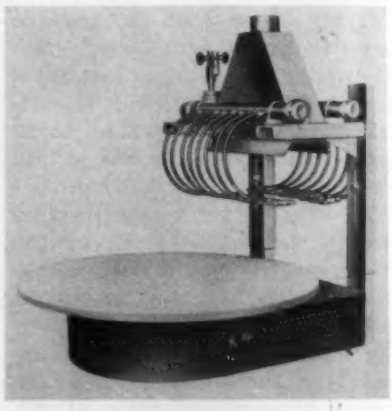
capacity from 25 to 100 lb. Each unit in the Weighblender is totally enclosed in a 12-gage dustproof housing. Air vents are provided to exhaust dust to the atmosphere or to a reclamation system. Each weigh hopper is entirely free of air lines, wiring and other obstruction that would reduce weighing accuracy. A solenoid operated air cylinder opens each inlet gate, permitting ingredients to flow to the weigh hopper. Gravity feeding is provided for cement ingredients. On completion of a weighing cycle, the knife edge beam of each scale actuates a limit switch and the air gate to close the gate instantly. Number of weighings is totalized on a directly connected mechanical counter. Electrically impulsed counters for remote indication can be supplied. Scale is available with either a manually operated or air operated bag holder. **Richardson Scale Co.**, Van Houten Ave., Clifton, N. J.

Circle 416 on Inquiry Card

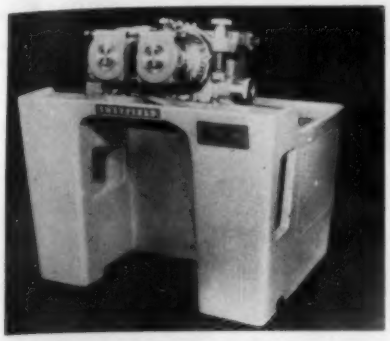


Turntable Heater

Brazing, soldering, annealing and hardening unit with turntable feature is applicable to either fully or semiautomatic operation. Workpieces to be heated, such as small parts, tools, etc., can be held by simple fixtures attached to power driven turntable and passed between two rows of burner nozzles as turntable revolves. Heat input is controlled by a valve adjustment on the burner manifold. Heating time is adjusted by variable speed drive on turntable. Burner nozzles are mounted with flexible copper tubing for easy adjustment to satisfy various types of work. Burner manifold is adjustable both

vertically and horizontally. Various burner nozzles are available for different requirements. Turntable unit burns any commercial gas—manufactured, mixed, natural, propane or butane. **Gas Appliance Service Inc.**, 1211 Webster Ave., Chicago 14, Ill.

Circle 417 on Inquiry Card



Thread Roller

Equipped with a hopper feed, new circular roll threading machine will produce up to 5200 parts per hour, ranging in thread size from ⅛ to ¾ inches outside diameter by 2 inches long. Rolling is performed by two interchangeable and reversible precision ground rolls rotating at different speeds and mounted on heavy duty roller bearing spindles. Drive is by positive worm and wheel control, powered by a 7½-hp motor. The machine has no cams, slides, hydraulic systems, fixed work rests or reciprocating motions. Parts are fed tangentially between the rolls by a revolving work feeder ring, falling free after rolling down a chute to a container. The feeder ring can be magazine loaded, manually or automatically. Completely equalized roll wear is assured by the different roll speeds and timing of the feeder ring. Pitch diameter adjustment is accomplished by a precision lead screw that advances the right hand roll and spindle through a micrometer type unit. Timing of the rolls is infinitely adjustable. Rolls are available for any type thread form within these size ranges: 0 to ¼-inch outside diameter by 2 inches long, 5/16 to 7/16-inch outside diameter by 1½ inches long, and ½ to 9/16-inch outside diameter by 1¼ inches long. **Sheffield Corp.**, Murchley Div., Dayton 1, O.

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Have you seen what this CAN DO FOR YOU?

SIZE 5040T* TORSION BAR

Torque control IMPACTOOL

NEW accuracy and speed for precision nut running jobs . . .

POSITIVE TORQUE CONTROL—a revolutionary use of a rugged steel torsion bar for precision control of torque—combined with the power and speed of the Impactool.

SIMPLE TORQUE SETTING—torsion bar adjusting sleeve is clearly calibrated for changing torque with easy-to-use torque jig.

TORQUE SETTING REMAINS CONSTANT—for any nut running condition until the adjustment is changed.

ELIMINATES "OVER-TORQUE"—impact mechanism rebounds instantly when preset torque is reached, tripping a foolproof rubber faced shutoff valve.

LOW MAINTENANCE—combines many of the proven features of Ingersoll-Rand Impactools, with their enviable record of dependable performance and low maintenance.

REVERSIBLE—full power in either direction.

NO CLUTCH—to wear, slip or require adjustments.

* **2 TORSION BARS PROVIDE MULTIPLE TORQUE SETTINGS**

No. L735 Max. torque 60 ft. lbs.

No. H735 Max. torque 90 ft. lbs.

For torques up to 550 ft. lbs. a Size 5340T Torque Control Impactool is available.

Get a free demonstration of Ingersoll-Rand Torque Control Impactools by an I-R AIR engineer now... or write for additional information.

Ingersoll-Rand

11 Broadway, New York 4, N.Y.

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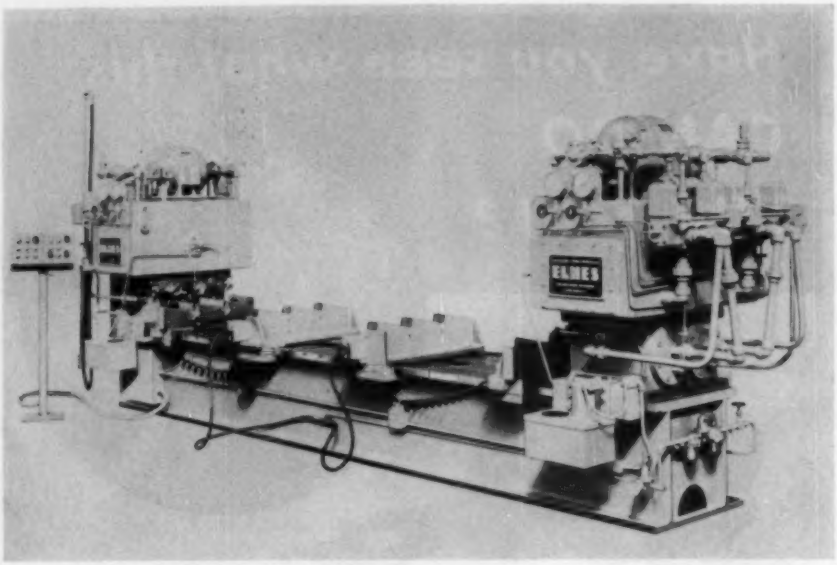
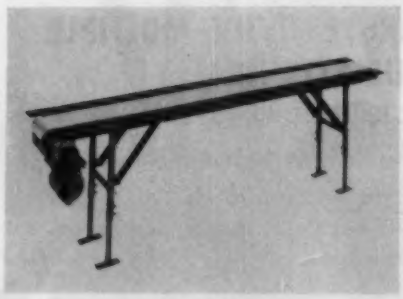


Double-End Tube Reducing Press

Fully automatic in operation and capable of producing 150 tubes per hour, new double-end tube reducing hydraulic press can be designed to accommodate a wide range of tubing diameters and lengths. Reducing both ends of a tube simultaneously is possible with the press. To reduce the 2-inch diameter thin-walled seamless steel tubing to the required 1¼-inch diameter at each end, it was found that two reductions would be required to prevent any buckling of the tubing. Therefore, a two-station machine was designed, using a preliminary reduction as well as a final reduction die. The dies are mounted internally in each ram along with an internal automatic hydraulic knockout in each ram. As the ram returns after the reduction, the knockout automatically ejects the tube.

In order to accommodate tubes varying from 3 to 12 ft in length in increments of 6 inches, one cylinder block with its accompanying pumping unit and controls can be moved along the bed by means of a motor driven lead screw. Keys across the bed take the thrust load. Tubes are fed automatically through the machine. Air operated tube clamps are used for the longer tubes, thus eliminating any tendency to bow during the reduction. The tube ends are lubricated prior to reduction by two lubricant pump and reservoir units, one for each end of the press. **American Steel Foundries, Elmes Engineering Div.,** 1150 Tennessee Ave., Cincinnati 29, O.

Circle 419 on Inquiry Card



Assembly Top Conveyor

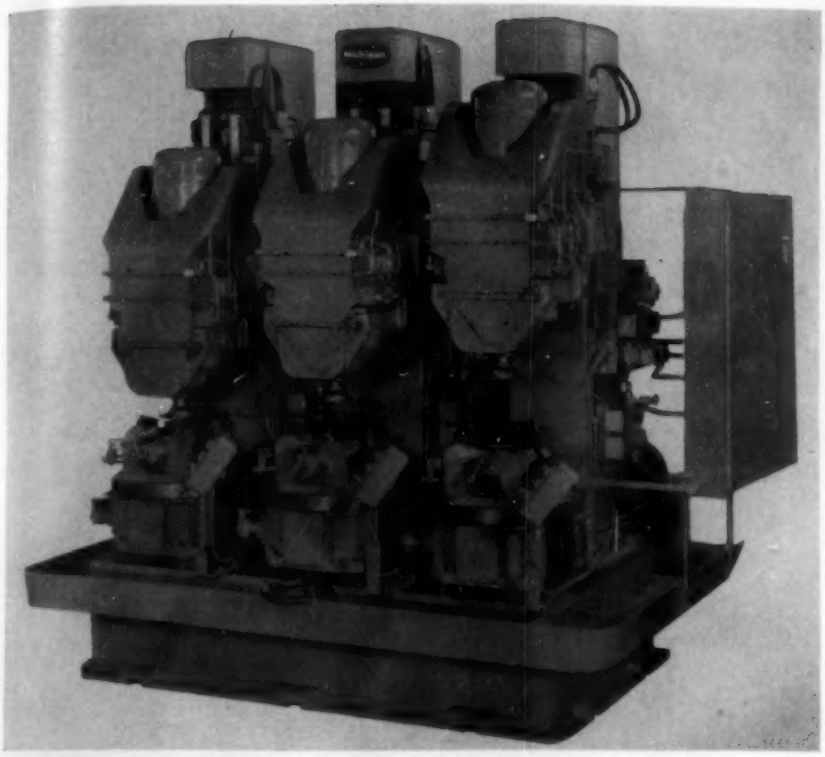
Designed for operation on small light parts and assemblies such as refrigerator and household hardware, automotive and other die casts, radio and television assembly, and plastic fabrication, new assembly top conveyor is called the Power Helper. Unit features a slider bed only 2¾ inches thick overall, including frame and belt. Conveyor is offered in three standard sizes of basic frame widths—12, 18 and 22 inches with belt widths 6, 12 and 16 inches; each is offered in 5, 10 and 15-ft lengths. Extended work aprons of standard 9-inch widths are offered as accessory equipment. Standard 10 fpm speed is provided by a ¼ hp, 110 v, 60 cycle motor; unit is available with a variable speed of 3 to 1 supplied by a 1/3 hp, 110 v, 60 cycle, single-phase motor. Standard mounting is on permanent base stands adjustable to any height from 28 to 36 inches, or may be supplied portable, caster mounted, on two swivel and two rigid 3-inch steel casters with or without floor lock on swivel caster stand. **Metzgar Conveyor Co.,** 408 Douglas St., N.W., Grand Rapids 4, Mich.

Circle 420 on Inquiry Card

Tube Aluminizer

Designed for use with tubes up to 27 inches, new cathode ray tube aluminizer is designated CRS-48 and features automatic operation. With the selector switch set on *Automatic*, the vacuum valves, pumps and the aluminum vaporizing coil function according to a preset cycle. The cycle can be varied over a wide range by simple timer adjustments. Complete evacuation and aluminizing cycle has been cut to several minutes, due to the high speed pumping system and easy mounting and removal of tubes. The CRS-48 is a totally enclosed unit; electrical components are mounted behind the control panel which can be drawn forward on tracks. The sides and back of the cabinet are also removable. **Kinney Mfg. Div., New York Air Brake Co.,** 3640 Washington St., Boston, Mass.

Circle 421 on Inquiry Card

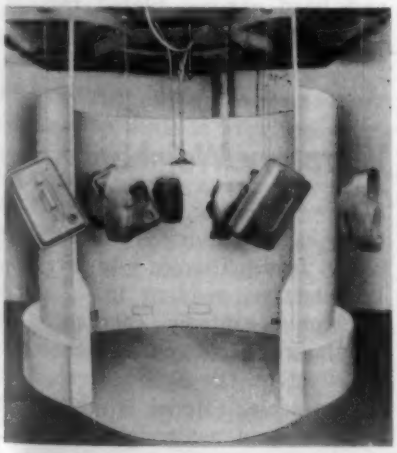


Triple-Head Milling Machine

Three-column, triple-head milling machine is designed to finish mill three slotted lugs on an automotive clutch ring. It features three standard vertical feed units mounted in battery on a single base, and three standard 20-inch hydraulic index tables, with three work stations on each head. Each feed unit is equipped with a horizontal cutting tool. Each index table is cycled to mill in turn each of the three lugs on the clutch ring. It is possible to finish mill all three slotted lugs, and hold them in the same plane with no variation, because all milling on a single clutch ring is done by the same horizontal cutting tool. Machine is completely automatic except for loading and unloading; it is designed for one-man operation.

New machine is synchronized so that when one head is down, the other two continue operating, permitting operator to unload and reload each head in successive steps. Production rate is 360 clutch rings per hour at 100 per cent efficiency. Machine is built to J.I.C. hydraulic and electrical standards, with automatic lubrication throughout. **Michigan Drill Head Co.,** P.O. Box 4643, Detroit 34, Mich.

Circle 422 on Inquiry Card

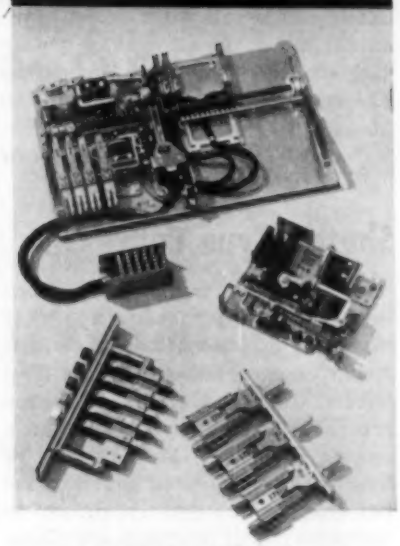


Electrostatic Spraying

Advance in the concept of paint application is accomplished by the new electrostatic spraying system which features a patented Ionic Gun with an Atomic Nozzle. The new system, powered by a 140 kva ionic high potential power supply utilizes a conveyor which is mounted in the center of the loop reciprocating vertically. A cone of disk shaped ionizing electrode is attached to the Atomic Nozzle on the Ionic Gun. The spray pattern,

WHEN YOU NEED

Switches and Keys...



. . . you'll be glad to know that expanded production at

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now makes available to you the top-rated products formerly distributed only to the Independent telephone industry.

This announcement promises the two most important things in your supply problem—*quality* in the products and *no priority* in orders for these hard-to-get items.

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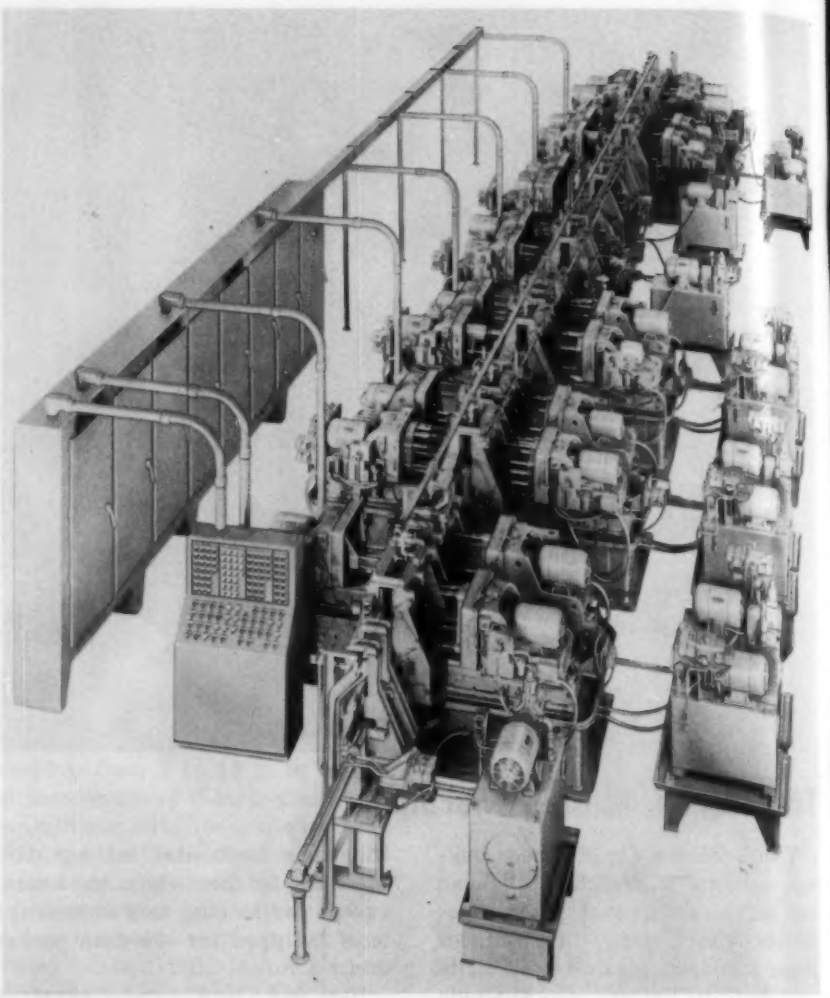
which can be adjusted to furnish either a 360-degree or umbrella shaped pattern (illustrated) by simply moving the outer sleeve of the nozzle either forward or backward, is set so that the spray will hit the cone or disk shaped electrode and deflect off it in the form of a mist. This ionized mist is attracted to the work being processed, which is at ground potential on the conveyor. **Scientific Electric,** Ionic Spray Div., 105-119 Monroe St., Garfield, N. J.

Circle 423 on Inquiry Card

Shuttle Type Conveyor

Adaptable to many installations and designed for many types of material handling, shuttle type conveyor operates on a single level without necessity of a second level return. Device operates within a trough or trench. Mechanically or hydraulically operated shuttle drive bar rests on the bottom. Hinged to the drive bar at intervals are blades which open to width of the trough as the drive bar starts its forward movement. Blades advancing with the drive bar move material in the trough to the maximum forward stroke of the drive bar. As the movement is reversed, blades fold back against the drive bar and by-pass the material advanced by the blade. Conveyor is practical for installations of great length with extremely low head room requirements. Stroke can be adjusted hydraulically to advance fast and return slow or to advance slow and return fast. **Industrial Filtration Co.,** Dept. J-471, Lebanon, Ind.

Circle 424 on Inquiry Card



Transfer Machine for Torque Converter Adapter Plates

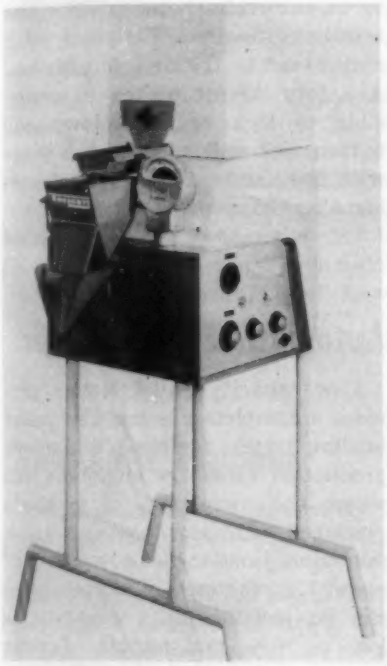
New 22-station, 70-ft long machine performs 155 operations on two types of torque converter adapter plates. No selection of the two different parts is necessary at the load station. Each machining station is equipped with an automatic part selector for unit control. Called the Economatic, machine processes 200 pieces an hour at 100 per cent efficiency. Special features include automatic lubrication of all moving parts, mist lubrication to all spindles to maintain uniform temperature in heads, automatic depth inspection of all holes before tapping, all spindles arranged for presetting of cutting tools, and bases sectionalized to simplify processing changes. Operations include 37 drilling, 12 reaming, 4 boring, 37 countersinking, 36 inspection and 29 tapping. The 22 stations are: One for loading, 14 for machining (including two for mechanical inspection), six for visual inspection and one for unloading. Two other features of the Economatic are that each machining station is equipped to take coolant from customer's central system, and chips are disposed through center of the machine into a conveyor in the floor. All standard and special machine parts are completely interchangeable; tapping spindles are of the individual lead screw type with precision ground and hard chrome plated threads. **Buhr Machine Tool Co.,** Ann Arbor, Mich.

Circle 425 on Inquiry Card

Vibratory Weighing

New weighing and filling machine is a vibratory type unit with a fast feed. The scale is extremely sensitive, reading in 1/16-oz; electronic controls (photoelectric cells) are used so that there is no effect on the action or reading of the scale. Model B scale may be used as a net weigher so that

material is preweighed in an automatic dump hopper and then discharged into the container. The dial of the scale is visible, and at any time the operator may press a check weigh button so that the weighed load is retained in the dump hopper and the weight checked without appreciable delay or the need of placing the package on a check weigh scale. An adjustable container shelf may be used when it is desired to weigh directly into the package. A third type of head is often used when items of unequal size or material of unusually high value are being

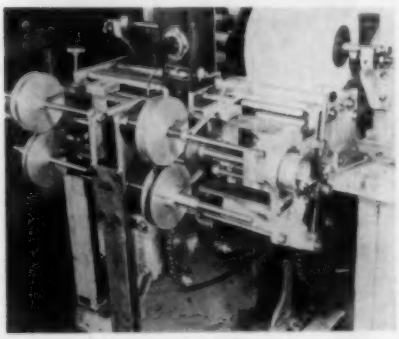


weighed. In this method the material is weighed in a scoop attached to the scale and the operator checks the weight on the scale dial so that the closest visible tolerance is obtained before discharging the weighed load into the container. Companion unit to the Model B is an adjustable elevator to feed material to the vibrator trough. Unless an even feed to the scale is provided, consistently even weights cannot be obtained. This necessary even flow may be had with many different products by adjusting the angle of elevation and the speed of the belt. Then, when the feed from the elevator is combined with that of the weigher and the elevator synchronized with the weigher, consistently good results are obtained. The elevator may be plugged into the Model B weighing machine so that the electric clutch is engaged each time the weigher operates. If the elevator is supplying the hopper on the weigher, or if it is used to supply any other make of weigher, it may be controlled by a foot switch. Scale is used in installations packaging automotive small parts such as nuts, bolts, screws, cotter pins, electrical connectors, etc.; the edible nut field; the milling industry; the drug trade; the horticultural trade; the seed trade, etc. Range of the Model B is from 1 oz to 6 lb. Rate of fillings per minute is up to 30, depending on the size of the package, the specific gravity of the product and the accuracy required. **Trescott Co. Inc.**, Fairport, N. Y.

Circle 426 on Inquiry Card

Coding Attachment

Designed for machinery which automatically manufactures, fills, weighs, and seals plastic packages, new roll-leaf coding attachment is used in a steel lockwasher plant. With the addition of this attachment, the hand marking of qualities and sizes on each package is eliminated. In the lockwasher plant, the washers and polyethylene coated polyester film are fed



into the machine; it automatically delivers neat packages of lockwashers which have been filled, weighed, thermosealed, crimped and coded, as shown in the illustration. Coding attachment can be adjusted to imprint various sizes and quantities of hardware and mill produce items handled by automatic packaging machines. **Industrial Marking Equipment Co.**, 454 Baltic St., Brooklyn 17, N. Y.

Circle 427 on Inquiry Card

LOVEJOY

Variable SPEED PULLEYS

SELECT-O-SPEED TRANSMISSIONS

Save You Money

HERE'S WHY:

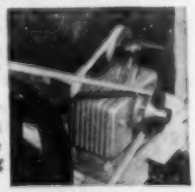
- ECONOMICAL IN COST compared to other variable speed transmission equipment. Simple in design but rugged in construction to give you long dependable service.
- EASILY INSTALLED on new or old equipment. Just as easy to operate. Finger-tip adjustment gives the right speed instantly.
- MAINTENANCE IS NEGLIGIBLE. No complicated mechanisms to get out of order. All parts can be readily inspected. Belts can be quickly adjusted or replaced.

Lovejoy Variable Speed Pulleys

are available in a complete range of sizes from fractional to 15 hp., ratios to 3 to 1.

Shown is a typical Lovejoy countershaft unit controlling speed of automatic spring coiler.

Lovejoy Select-O-Speed Transmissions



can be supplied with hand wheel or lever control. Fractional to 5 hp., ratios to 10 to 1.

This Lovejoy Select-O-Speed is used to control the speed of a printing press.

For your variable speed application, there is a type and size Lovejoy unit that will give you initial economy, dependable performance and long service life.

GET FULL DETAILS NOW!

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LOVEJOY FLEXIBLE COUPLING CO.

4951 W. LAKE STREET • CHICAGO 44, ILLINOIS

Mfrs. of Flexible Couplings, Variable Speed Pulleys and Transmissions, Motor Bases and Universal Joints.

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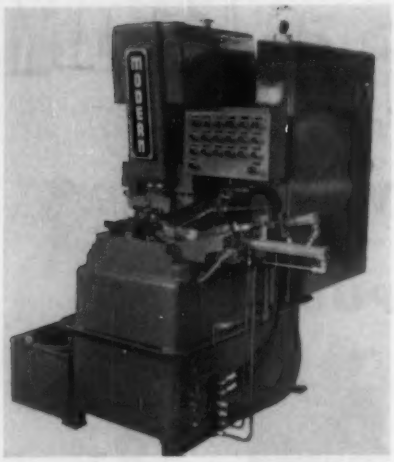


Gear Processing

Automatic operation of two-station external machines and single-station internal machines makes possible deburring and chamfering five gear teeth per second. Deburring and chamfering both sides of external gears require no operator attention with an automated two-station external machine. With the machine selector switch in the automatic position, the loading disk picks up one gear at a time from loading storage and permits it to slide forward into the loading station. At the completion of one cycle, the part moves along to the first work station where a spring loaded elevator places the gear on the work spindle. Five indexes of the pilot gear are allowed to make certain that the part is properly engaged with the workpiece. After the gear is completely deburred and chamfered, the elevator returns the part to the endless chain conveyor where it moves to the turnover station and is rolled-over 180 degrees for deburring and chamfering of the second side. Deburring and chamfering of the second side of the gear is identical with the operations performed on the first side. If either loading storage ahead of the machine is empty or unload storage from the machine is full and cannot accept additional gears, remotely located switches ahead of and following the machine are opened, stopping the cycle. Single-station internal machine deburrs and chamfers gears ranging from 2 to 20 inches. During a typical automatic cycle, the movement of loading cylinder rotates a loading disk and permits one part to pass through at a time into the transfer line. The internal gear to be deburred and chamfered moves into an elevator that locates the part centrally above the work station. At the same time, a completed gear is ejected into the exit chute. As the transfer cylinder returns, the quill moves downward and the workpiece moves into contact with the radial gaging pinion. Since the radial pinion turns in timed relation to the spline driver, this interaction insures that the spline driver mounted on the spindle will enter the internal gear teeth. The quill continues its movement carrying the workpiece down into the work station, starting the chamfering cycle by tripping a limit switch. After the workpiece has made one complete revolution and all gear teeth are deburred and chamfered, the reciprocating form cutter stops in the retracted position and the part is raised from the work station completing the cycle. **Modern Industrial Engineering Co.,** 14230 Birwood Ave., Detroit 38, Mich.

Circle 428 on Inquiry Card

Fast Cycle One-Ton Press

Designed to cut production costs on such operations as assembling, riveting, punching, marking, trimming, pelleting, compacting, testing, straightening, broaching and swaging, new one-ton press duplicates ram pressure every stroke and features precision ram alignment. Called the Multipress, the machine operates on 110v, 60 cycle single phase circuit. It can be wired for operation on 220v single phase. The hydraulic unit, with ram pressure of 500 to 2000 lb, is electrically controlled and can be operated individually or in a production line with a dial table, power screw feed hopper or stock feed. Two operating switches, one on each side of the press, are used to start the operation. Holding both buttons will cause the ram to stay down under full pressure and tonnage as controlled by the relief valve. Releasing the buttons immediately after the ram starts will cause it to go down until it meets a resistance, then automatically reverse, return to the up position and remain motionless. The relief valve may be set to the desired pressure. A safety circuit makes it impossible to lock or tape down one button and still operate the press with one hand. **Denison Engineering Co.,** Columbus, O.

Circle 429 on Inquiry Card

Automatic Pallet Loader

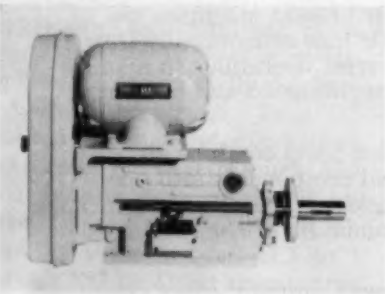
Low capacity pallet loader provides a completely automatic pallet loading system for the plant where production rates are moderate and where the complexity of products produced simultaneously is at a minimum. Loader has a capacity of about 20 cartons a minute and can be justified at a capacity as low as five per minute. Loader is designed to handle pallets up to 48 by 48 inches with a maximum load width including overhang of 52 inches and maximum length of 50 inches. Machine can be loaded with pallets one at a time or in stacks. The weight of a load on a pallet is unlimited since the pallet sets directly on the floor and no weight is carried by the loader. The weight of a layer of cartons has been limited to approximately 600 lb but can be increased with moderate revisions. Loader handles sealed cartons with a top diagonal dimension not in excess of 21 inches. In operation, the new machine forms the layer in the same manner as the conventional high speed machine. Loads are received from production onto the feed and accelerator conveyor which in turn discharges onto the package conveyor. Packages are rammed onto

the layer conveyor which is a belt-driven, live roll unit. Once a layer is formed, the control system notifies the transfer head that a layer is complete and ready to be removed. The hoist lowers the head onto the top of the completed layer and at the same time a closer bar operates from the side to tighten the layer. The live roll layer conveyor effects the same action in the other direction. Pallets are stacked on either side of the machine and are alternately loaded. The loader can be changed over to a different size carton by changing the grid of the pickup head. **Lamson Corp.**, Syracuse 1, N. Y.

Circle 430 on Inquiry Card

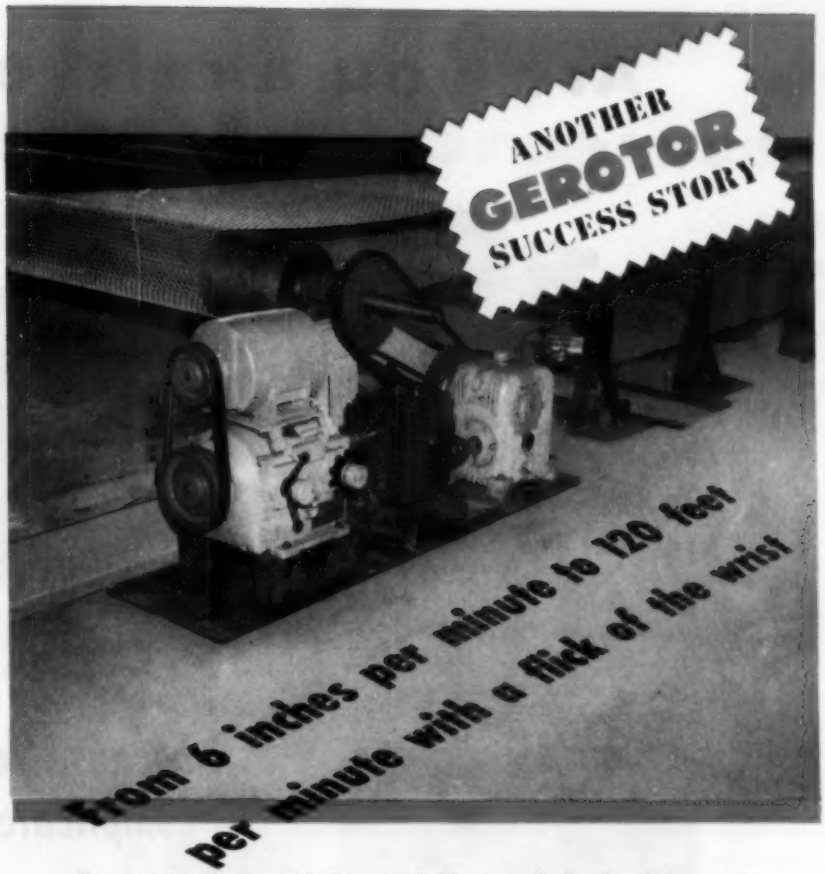
Automatic Tapping

New machine tool component is designed for automatic tapping. Operating cycle of the unit is: Rapid approach of the tap to work, tapping through lead-screw with locked circuit feed and thrust control, then rapid return to the start



of the cycle. Operation dependability and greater precision are provided by the bearing and lead-screw oil bath systems. Standard Model 555 has 5-inch quill travel. Tapping capacity is up to 7/8-inch in steel under continuous duty. **Drillmation Co.**, 21511 John R St., Hazel Park, Mich.

Circle 431 on Inquiry Card



Our customer* needed a variable speed device to power a conveyor "assembly and test stand" which would accommodate metal conveyors up to 18 feet in width and up to 100 feet long. The Gerotor Variable Speed Hydraulic Transmission was the drive selected because it has a:

1. *wide enough speed range*
2. *smooth enough power flow*
3. *built-in overload protection*
4. *compact size, and*
5. *low maintenance factor.*

The installation engineered by Gerotor allows the operator to run the conveyor at speeds *from a smooth creep condition of 6 inches per minute to 120 feet per minute.* The added versatility of being able to adjust the torque output at any speed was theirs at NO EXTRA COST, and the conveyor can be stopped or reversed by means of the Gerotor Transmission.

If you have a hydraulic transmission problem . . . bring it to Gerotor. Free literature available . . . *write:*

*name on request.

Progress Through Fluid Power by—

GEROTOR

MAY CORPORATION

MANUFACTURERS OF—

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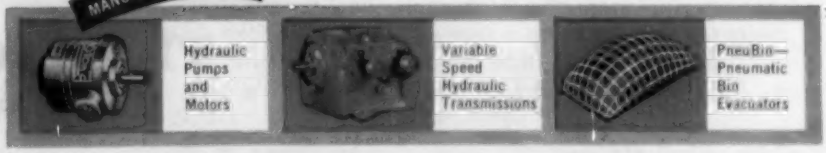
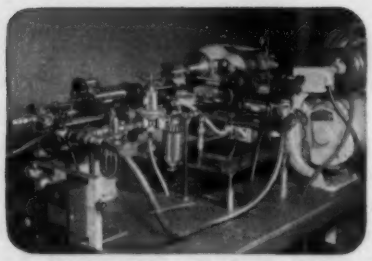


Circle 574 on Inquiry Card

Are you afraid of AUTOMATION . . .

. . . because you think it's too complicated and expensive?



For example, this lathe, equipped with two Bellows Fluid Power Units—performs four operations on the steel shells of oil seals. The fluid power method stepped up production 450%.

Here's a case where Fluid Power control enables one operator to turn out the work of four. He services two units like the one shown. The operation is a critical reaming job on the six chambers of a revolver cylinder.

You don't need to be . . .

You don't need to invest heavily in special machinery—or build intricate robot production lines. For many of automation's practical advantages can be realized with only nominal investments of time and money.

Perhaps you don't yet know how quickly and inexpensively Bellows *fluid power work units* can be used to convert your present machines to automatic operation. Or how economically they can be used to combine several operations in a single special-purpose machine, designed and built in your own plant.

These versatile, precision units combine air, hydraulic, and electrical components into one compact *fluid power* package. This complete-package design assures you a minimum of engineering and installation costs.

In addition, The Bellows Company offers you—through our staff of more than one hundred Field Engineers—the technical know-how to put Fluid Power to profitable use in your own plant.

1376-A

It costs you nothing to get the story. Simply write for your copy of our four color booklet, Bulletin ML-3. Address Dept. AU-756. In Canada, Bellows Pneumatic Devices of Canada, Ltd., Toronto.

The Bellows Co.

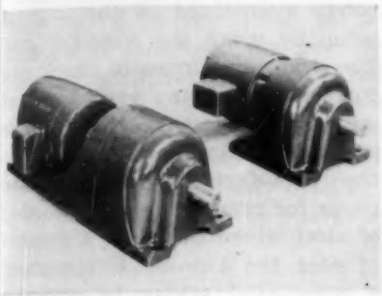
AKRON 9, OHIO

Circle 575 on Inquiry Card

AUTOMATION new components

Parts, elements and devices designed for creating more automatic systems

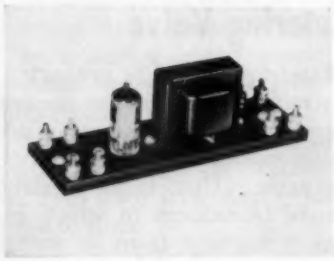
For detailed information and literature, use card page 17



Gear Motors and Drives

Designed for applications destructive to ordinary gear drives where heavy shock loads must be handled without damaging effect, and where continuous operation makes downtime costly, new gear drive, above left, is called the Motogear. Rigidity of the high speed shaft and pinion is provided by a straddle mounted pinion which readily withstands shock, reversing and heavy loads. The motor can be replaced quickly, merely by removing four bolts and separating the coupling. Draining of oil is unnecessary. The motor mounting bracket design facilitates rapid motor realignment. Type DB double reduction Motogears have ratios from 6.2 to 1 through 38.4 to 1 and transmit up to 60 hp. Type TB triple reduction Motogears have ratios from 47.1 to 1 through 292 to 1 and transmit up to 20 hp. The second unit, called the Gearmotor, has rabbet fit, flange mounted NEMA motor, and maintains positive and permanent motor alignment, providing quiet, dependable service whether mounted on the floor, wall or ceiling. The flange is standardized, one size per motor rather than two or more, to permit use of a more universally applicable motor. Type DF double reduction Gearmotors have ratios from 6.2 to 1 through 31.4 to 1 and transmit up to 30 hp. Type TF triple reduction Gearmotors have ratios from 38.4 to 1 through 292 to 1 and transmit up to 20 hp. **Link-Belt Co.**, Prudential Plaza, Chicago 1, Ill.

Circle 432 on Inquiry Card



Electronic Relay

Designed to meet the requirements for follow-through, high speed and sensitive instrument controlled relaying devices, new electronic relay is capable of complete follow-through action. Brushing of contacts even momentarily effects immediate operation of the controlled device. Relay responds to controls from a highly sensitive wire contact. There is no arc operation; only microamperes are drawn by the grid circuit. Tube capacity is adequate for direct control of the load operating solenoid. Fundamental circuit is adaptable for a variety of functions including time delay. The relay is used as a dc voltage detector with delayed inverse time response. This arrangement has been useful for overload detection by exciter voltage measurement of alternators. **Automatic Switch Co.**, 391 Lakeside Ave., Orange, N. J.

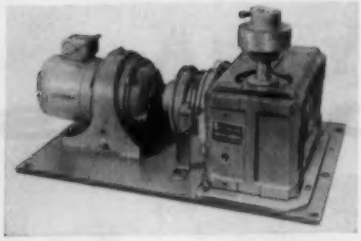
Circle 433 on Inquiry Card

Thermal Time Delay

Designed to meet the requirements of both light and heavy industrial control and electronic equipment, new series of thermal time delay relays has the operating mechanism encased in a dust tight shell. Omission of hermetic sealing reduces the cost of the units for applications where such sealing is not needed, and durability is improved by the elimination of all glass. The new relays, designated as the Red Dot series, fit octal tube sockets. Contact rating is 3 amp at 230v ac. Relays are available with either normally open or normally closed single pole contacts.

Standard heater voltages are 6.3, 26.5, 115 and 230. Heaters operate interchangeably on ac or dc and all relays may be energized continuously without damage. Relays are available in standard delay times of 2, 5, 10, 20, 30, 45, 60, 90, 120 and 180 seconds. **G-V Controls Inc.**, Hollywood Plaza, E. Orange, N. J.

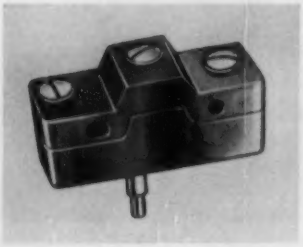
Circle 434 on Inquiry Card



Power Unit

Designed for straight line transfer machines or other indexing equipment, completely assembled power indexing unit is known as the Trans-Pac. It includes a gear motor, control shaft drive sprockets, brake actuating cam and limit switch, electric clutch brake combination and mounting ring, indexing mechanism and drive shaft coupling. Components, mounted on a steel base plate, are ready for inclusion in a machine and require only necessary connections to control panel and driven parts of the machine. The indexing mechanism, a Ferguson roller gear drive, features modified trapezoid acceleration characteristics (initial force of zero and a gradual increase to maximum acceleration value) to provide smooth, vibration free indexing. An electric clutch brake combination provides remote control of dwell and permits jogging and inching of machine elements with maximum speed and design flexibility. **Ferguson Machine & Tool Co.,** Roller Gear Div., P. O. Box 5841, St. Louis 21, Mo.

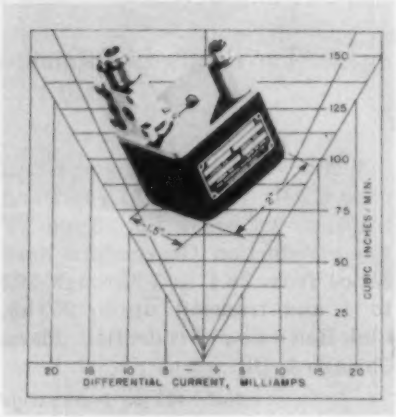
Circle 435 on Inquiry Card



Snap Switch

Applicable in the aircraft and machine tool industry where durability and vibration resistance are required, new snap switch is designed with a raised pad at the midpoint of the base and utilizes rolling spring principle. The open terminal is positioned on the raised pad while the closed and common terminals are at opposite ends of the base and at a lower level. This design simplifies wiring to the terminals. It also permits lower cost screw terminal construction. **Acro Mfg. Co.,** Columbus 16, O.

Circle 436 on Inquiry Card



Metering Valve

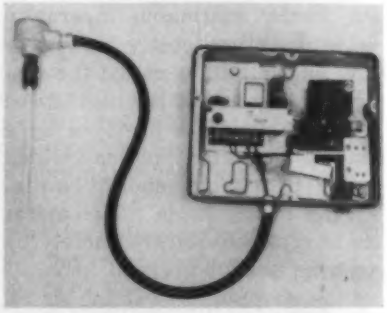
Electrical signal is converted to a straight line gradient response for either hydraulic signal or pneumatic applications by new metering valve. Unit is an electrohydraulic transducer to which pressure is supplied from an external pressure source, controlled by electrical input signals of a differential type. Valve is designed to produce differential flows in proportion to the differential electrical input signals. Metering valve is used in control circuits for industrial machinery, ordnance, prime movers, aircraft, etc. Valve is of single-stage construction. **National Water Lift Co., Div., Cleveland Pneumatic Tool Co.,** 2220 Palmer Ave., Kalamazoo, Mich.

Circle 437 on Inquiry Card

Automatic Measuring

Designed to eliminate trial and error methods of obtaining and holding repeat lengths, new unit, called the Auto-Set, is used in the manufacture of corrugated cartons, in the cutting of steel coils into individual sheets and in the sheeting of any other material from a roll to individual sheets such as plastics, fabrics, and all types of papers including cellophane, glassine, wax, etc. With the Auto-Set, which electronically measures each individual sheet, the measuring machine can be accurately maintained on the original setup by using the Auto-Set dial. The device continues to check and compensate for any variation that might develop while the machine is running. On operations such as the manufacture of corrugated paper for cartons and the sheeting of steel where there are a number of sizes, the Auto-Set brings about a substantial saving by reducing material waste, decreasing changeover time and improving quality. **Machine O'Matic Inc.,** 2045 N. Hoyne Ave., Chicago 47, Ill.

Circle 438 on Inquiry Card



Level Controller

The accuracy of electronic capacitance sensing elements is used by new controller to detect minute changes in levels in tanks, drums, process baths, pipelines and other conveyors. Electronic signals are then converted by the control into proportional pneumatic output. The modulating air output is sufficiently powerful to operate control valves and other pneumatic control equipment. Servomotors and other rebalance mechanisms are eliminated. Because of the modulating control action of the new device, much of the wear caused by *On-Off* sys-

tems is avoided. The closed loop control is largely unaffected by external changes in voltage, air supply, temperature and pressure. It provides high speed response and may be adjusted to give a full change of air pressure output for a 2 ft change in the level of a hydrocarbon or similar low dielectric material. An air output signal may be connected for either forward or reverse operation. The level control has applications in the petroleum, chemical, food processing and other industries where accurate control of level and flow are necessary. For use in hazardous locations, the new device is available in special dust proof and explosion proof cases. **Fielden Instrument Div., Robertshaw-Fulton Controls Co.,** 2920 N. Fourth St., Philadelphia 33, Pa.

Circle 439 on Inquiry Card

Subminiature Converter

Shaft position is translated into unambiguous Gray binary digital code by new subminiature converter which is 2.156 inches in diameter by 0.8-inch in length. Converter provides total resolution of 2^8 (256 segments) per shaft revolution. Other code variations and count capacities may be provided using the same basic construction. The unit allows complete continuous rotation in either direction and readings can be taken when shaft is rotating or while it is stationary. Output can be either serial or in parallel, depending on input. Contact segments and takeoff brushes are of precious metal, and the shaft is supported in stainless steel ball bearings. Input torque is 0.1 oz-inch. Unit operates dependably between −55 to 80C. **Marlee Associates Inc.,** Route 46, Parsippany, N. J.

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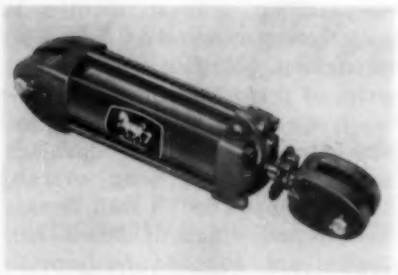


Cylinder Stroke Control

Designed for operating pressures up to 1200 psi, hydraulic cylinder features newly designed piston rod. Called the Strokontrol ram, the rod incorporates an easily adjusted, accurate hydraulic depth stop. The thumb screw collar on the piston rod can be set at any desired position to stop the retracting stroke at the given point until the collar position is changed. The ram utilizes high strength aluminum alloy castings for light weight. Other construction features include a chrome plated piston rod, blocked V seals and a honed barrel for precision operation and long life. Double-acting cylinder has a 3½-in. bore, and is available in stroke lengths up to 16 in. **Char-Lynn Co.,** 2843 26th Ave. South, Minneapolis 6, Minn.

Circle 441 on Inquiry Card

All Purpose Relays

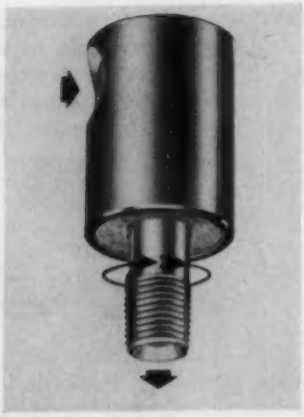
Designed to meet rigorous standards for aircraft relays, new device fulfills industrial needs for a compact, lightweight relay capable of handling power loads usually demanded of much larger and heavier relays. Insulation is of high grade molded phenolic material. Contact rating is 15 amp at 115v ac or 32v dc noninductive load. Relay is available in wide range of coil operating voltages for either ac or dc. **Ohmite Mfg. Co.,** 3681 Howard St., Skokie, Ill.

Circle 442 on Inquiry Card

Conveyor Converters

Existing belt conveyor lines are converted to permanent, nonelectric magnetic conveyors by addition of new unit called the Magna-Rail. The device is a specially designed circuit of Alnico V magnetic castings, 4 inches wide, 1 15/16 inches high, available in standard lengths of 3, 4, 5, and 6 ft. By placing the needed lengths under the conveyor belt, conversion to a magnetic conveyor or elevator system is accomplished. Unit eliminates slipping, sliding or falling off of ferrous materials such as nails, cans, lids, metal parts or scrap; material can be moved up inclines as steep as 75 to 80 degrees. Magna-Rail Model MCR-3112 is for conveying average ferrous objects of medium size such as can covers, caps, small stampings, etc. at speeds up to 85 fpm. Model MCR-316 is designed for handling, at greater speeds, more difficult materials, unusually shaped objects, where contact with the belt is small, where nonmagnetic and magnetic components are involved, and on tangled masses or objects. Magna-Rails are completely nonelectric; no outside power is required and no maintenance is needed. **Eriez Mfg. Co.,** Erie 6, Pa.

Circle 443 on Inquiry Card



Swivel Joints

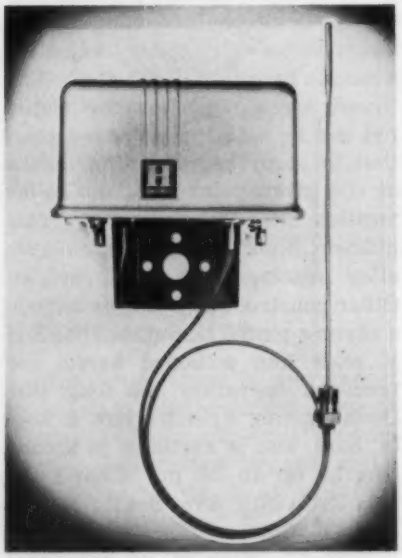
Designed especially for hydraulic or pneumatic service on pipe, tubing or hose, new joints are of the single plane, swivel type. They are designed to provide for up to 360-deg. turning or rotating motion on machinery or other places where flexible piping or tubing is required. Joints can be used as connectors for hose in reducing hose length by eliminating sharp bends, and increasing hose life by relieving all twisting stresses. New joints are available in ball bearing and thrust bearing types suitable for pressure as high as 2000 p. s. i., depending on the size of joint. Temperature ratings recommended range from −20F to 225F. Joints are equipped with O-ring seals and have low rotating torque at all pressures. The bearings are sealed and require no lubrication maintenance in normal service. Standard sizes are ¼ and ½-in.; ⅜ and ¾-in. sizes are available on quantity orders. **Barco Mfg. Co.,** Dept J-24, 500 North Hough St., Barrington, Ill.

Circle 444 on Inquiry Card

Air Cylinder Silencer

Designed to reduce noise and blast from air cylinder exhausts, compact air exhaust muffler is made of noncorrosive materials throughout. Muffler consists of a series of perforated disks held between spacers in a compact cylinder only 31/32-inch in diameter and 4 3/16-inches long overall. Body is tapped for ⅜-inch female thread, and standard brass hex nipples are supplied to provide either ¼ or ⅜-inch male fittings. **Modernair Corp.,** 400 Preda St., San Leandro, Calif.

Circle 445 on Inquiry Card



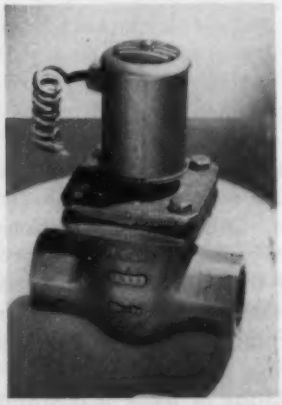
Pneumatic Transmitter

Accurate measurement of either temperature or gage pressure, as well as absolute pressure over narrow and wide spans is possible with pneumatic transmitter. New instrument converts process temperatures from −375 to 1000F or pressures of from 40 to 600 psi to a standard 3 to 15 psi output. Simple adjustments make it possible to measure temperatures or pressures and to vary the span width or shift it anywhere within the range of the instrument. Flexibility and accuracy of new instrument make it valuable where close process control and versatility are required, ie., in the food, chemical and petroleum industries. Unit is shock mounted and designed to resist the effects of vibration. It compensates for ambient temperature and barometric pressure changes, eliminating the need for adjustment as these conditions change. Instrument operates on the force-balance principle which virtually eliminates motion, reducing wear and increasing life span. On a full-scale deflection, the primary element moves a few millionths of an inch. A small, sensitive stainless steel bulb provides fast response to temperature changes. Pipe, wall or horizontal well mounting is provided by a universal mounting bracket. Illustrated model has a thermal system for temperature measurement. **Minneapolis-Honeywell Regulator Co.,** Industrial Div., Wayne & Windrim Aves., Philadelphia 44, Pa.

Circle 446 on Inquiry Card

Solenoid Valves

Designed to eliminate hammer and shock in automatic or remote control of chemicals, steam, air, gas and other liquids, packless, piston-pilot operated stainless steel valves are available in normally closed and normally open types. Three sizes are offered for each type: 1¼, 1½ and 2 inches. Features of the valve include all stainless steel construction, renewable Teflon disks, full ports, unbreakable stainless steel piston rings and packless operation on a wide range of operating pressures. Waterproof molded coils for temperatures to 250F and silicone insulated coils for higher temperatures are available. Coils are interchangeable between sizes and with all other company valves. Explosion proof coil housings, special assemblies and alloys are available to meet various requirements. **J. D. Gould Co.,** 730 E. Washington St., Indianapolis 2, Ind.



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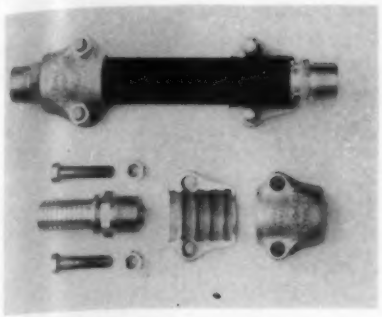

Clamp Fitting

Designed for heavy duty applications for hydraulic lines, steam hoses or liquid petroleum gas transmission, two-bolt clamp fitting is made of heavy malleable iron and is secured by two large heat treated bolts. It is also a reusable fitting that is error free in assembly and has the feature of swift hose replacement by maintenance personnel who merely leave the fitting on a machine and insert the new hose over the fitting stem. Engineered for use on heavy road building equipment, as replacement fittings for tractors and farm equipment, on oil well equipment, shipyard and dock machinery, for fuel transfer lines, on machine tools, and for general heavy duty plant equipment maintenance, the rugged clamp fitting is made in eight sizes to accommodate hose from ¼-inch to 2 inches in diameter. For use with all standard type high pressure hoses of the proper dimensions, the triple wire braided hose and clamp are rated for pressures up to 3000 psi; with double wire hose, it is also rated up to 3000 psi; with single wire hose it has a 2500 psi rating; and used with two fiber braided hose, it is rated for service up to 1500 psi. **Flex-O-Tube Div., Meridan Corp.**, 2525 Jim Daly Rd., Inkster, Mich.

Circle 448 on Inquiry Card

Flow Meter

Designed for the measurement and control of the mass rate of flow of liquids, new unit uses the rate of heat transfer through the boundary layer of a liquid to obtain a measurement of flow. The instrument is especially suited for corrosive fluids and gases, slurries, hydrocarbons, biologics, beverages,

Now...*Electronic wings for your weights!*

...bringing you TOLEDO accuracy wherever you want it in the form you want it!

REMOTE DIGITAL INDICATION

REMOTE TAPE PUNCHED

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REMOTE TYPEWRITING

Weight data can now go anywhere . . . in the form most useful to you . . . through Toledo's remarkable new electronic system of remote data handling. Even though the weights originate in production, inspection, testing, shipping or receiving, the weight data travels instantly for remote digital recording in the form and location that best suits your needs. This greatly extends the capabilities of TOLEDOmation and assures for you maximum weight cost control and usability of weight data.

NEW AUTOMATIC BATCH CONTROL SYSTEM ... with Remote Digital Weight Recording

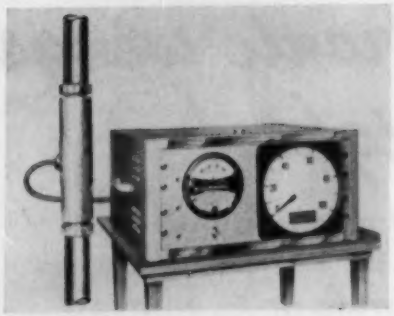
This Toledo cabinet interlocks 22 scales in an automatic batching system.

Through TOLEDOmation all ingredients are fed into successive batches in proper sequence, including operation of gates and feeders. In addition, all dials are automatically scanned and the digital weight data is recorded on an electric typewriter for each batch.

SEND FOR BOOKLET ON NEW TOLEDO REMOTE DIGITAL WEIGHTS ... Toledo Scale Company, Toledo 1, Ohio

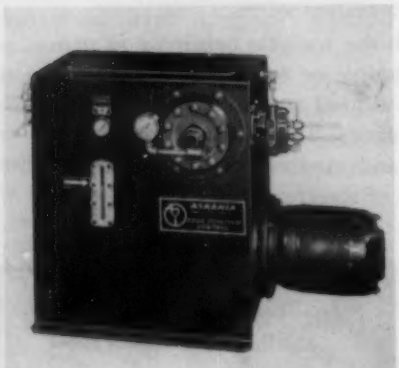
TOLEDO® HEADQUARTERS FOR **SCALES**

Circle 576 on Inquiry Card



etc., and has many applications in the chemical, pharmaceutical and food processing industries. Its linear scale covers a wide range of flows including pulsating type. The measuring elements are not exposed to the fluid and there is no pressure loss or danger of clogging. For remote indication and control, a directly produced electrical signal is available. The device is fully electronic without mechanically moving parts. It is designed for continuous heavy duty operation and requires no adjustments. The flow indicating instrument has a 16-inch long scale which is easily read even at relatively wide range. **Industrial Development Laboratories Inc.,** 17 Pollock Ave., Jersey City, N. J.

Circle 449 on Inquiry Card



Edge Position Control

Two complete and independent hydraulic controllers in a single housing are designed for high speed tentering, laminating or any other edge position control application where two edges are guided simultaneously. Called the twin jet regulator, new unit when operating through a 2-inch bore cylinder in high speed tentering applications, will position tenter frame guide rails at rate of 3 inches per second. Pneumatic edge detecting system does not touch web and uses extremely low pressure air, yet reacts immediately to any change in web position. **Askania Regulator Co.,** 240 E. Ontario St., Chicago 11, Ill.

Circle 450 on Inquiry Card

Switch Kit

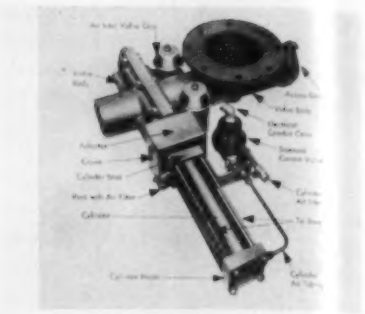
Designed for experimental engineers and those who plan, build, repair or test electrically operated controls, new kit provides all components necessary for assembly of a variety of contact switch combinations. The kit includes compartments containing assortments of contact blades, insulators, separators, tension plates, angle brackets, side lugs, nylon lifters, contact rivets, washers, screws and bushings. Standard and midget size blades are furnished. **Guardian Electric Mfg. Co.,** 1621 W. Walnut St., Chicago 12, Ill.

Circle 451 on Inquiry Card

Material Handling Valves

Designed for efficient flow control in the pneumatic transport of fine solid materials, Type C materials handling valves feature self-feeding, nonplugging operation with positive shut-off, maximum carrying capacity, minimum frictional wear, and ease of maintenance in the handling of such materials as boiler fly ash and other industrial dusts. Intended for installation in vacuum transport piping systems, Type C valves are available with either air-electric, remote or manual controls. The self-feeding feature of these valves eliminates plugging. Atmospheric air, admitted into the vacuum system through the inlet ports, continuously picks up and sweeps material through the valve and into the transport piping at rates automatically matched to the increases and decreases of the load in the system. Because the rate of feeding is continuous and commensurate with the air flow, there is no sudden application of full vacuum to plug the system. Valves have sliding shut-off gates that provide protection against leakage. Wear is minimized because material is transported at maximum concentration over the full area of the pipe. Because the bulk of the material does not come into contact with the pipe walls, any sandblasting effect is eliminated. For air-electric operation, the valves are equipped with air cylinders controlled by three-way solenoid valves. For remote operation, valves are equipped with air cylinders controlled by three-way valves mounted on a central control panel. For manual operation, they are equipped with either push-pull rods or with chainwheels and hand chain. **Allen-Sherman-Hoff Co.,** 259 E. Lancaster Ave., Wynnewood, Pa.

Circle 452 on Inquiry Card

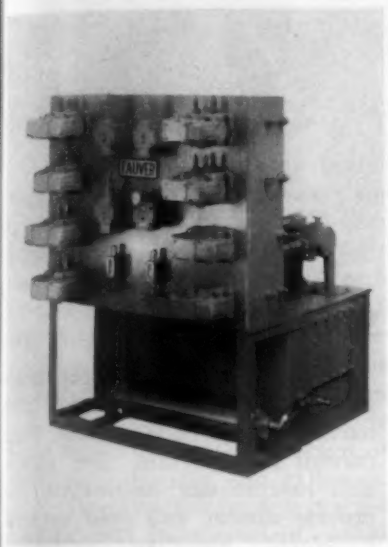


Layout Template

Designed to reduce the time required for graphic panel layouts, new layout template contains

scaled outlines representing the most frequently used industrial instruments. The representations are scaled accurately at 2 inches to the foot. Also provided are outlines for pumps, valves and other graphic panel symbols, as well as vessels. Layout template is fabricated from 20 gage, frosted lucite. **Panellit Inc.**, 7401 N. Hamlin Ave., Skokie, Ill.

Circle 453 on Inquiry Card



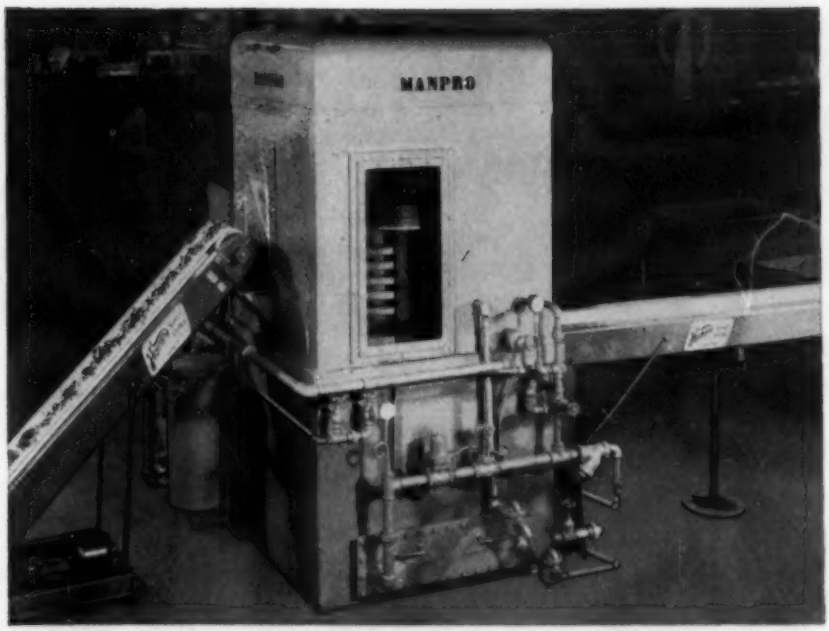
Power Unit

All operations of a machine that welds and forms are provided by power unit. Flow control valves provide uncompensated control, located between solenoid valve and its subplate. Two acorn nuts protruding from top allow for a fine adjustment to speed in each direction. Free return flow feature is incorporated on each valve. Other equipment in unit includes a pump; fittings and tubing; 10 hp, 1200 rpm motor; 60-gal reservoir; heat exchanger; water control; three globe valves; eight solenoid; one reducing and three sequence valves; and two gages. **J. N. Fauver Co. Inc.**, 51 W. Hancock, Detroit 1, Mich.

Circle 454 on Inquiry Card

Analog Computer Units

Various component combinations of a correlated modular array of electromechanical analog computer components, called Servomation Building Blocks, provide the means



Two Homer "Space Saver" Magnetic Conveyors in use with a Manpro Vibra Degreaser—one feeds screws into the Vibra Degreaser . . . the other receives them to discharge into tote boxes. Even though these cylindrical pieces are conveyed up a steep incline, there is no slipping, rolling or loss of pieces.

TEN ANSWERS TO CRITICAL QUESTIONS ABOUT HOMER MAGNETIC CONVEYORS

MAGNETIC ASSEMBLIES
Greater magnetic strength per unit length, permits faster belt speeds (up to 250 fpm) at steeper angles (up to 90°). Increases automatic handling of parts without damage to critical finishes, caused by parts hitting or bumping each other . . . ends slipping and loss of parts because of steep inclines, belt resiliency or bouncing over belt cleats.

HEAD PULLEY
Head pulley at discharge end of conveyor contains an adjustable, permanently magnetized assembly (Patent Pending) . . . requires no nosed-over section for delivery of parts to tote boxes, machines or other conveying equipment.

BELTS
No special belts, cleats or buckets required. If belt replacement is needed, a standard stock belt can be purchased from a local supply source.

FLEXIBILITY
Can be supplied to convey horizontally or vertically (90°). Custom built to convey on underside of conveyor for parts turn-over jobs . . . Custom built for parts rejection . . . Custom built for multi-story conveying and many other unusual applications.

FLOOR PICK UP
If the application requires floor pick up, the "Space Saver" can be supplied with a magnetically energized tail pulley for this purpose.

LOADING
The "Space Saver" can be supplied to pick up pieces from floor, or can be loaded at any desired height above floor . . . does not require hopper or side boards in most applications. These can be supplied if desired.

DRIVE
Positive chain drive with choice of gearhead or separate motor and speed reducer.

SAFETY
Drive mounting on standard units designed for maximum safety to workers.

MAINTENANCE AND REPAIR
Wherever possible, standard component parts which can be purchased locally if desired have been incorporated into the "Space Saver."

SIZES
A full range of standard sizes (85 by count), with belt widths from 6" to 24" and 4' to 20' belt centers. Custom models available to suit your specifications.

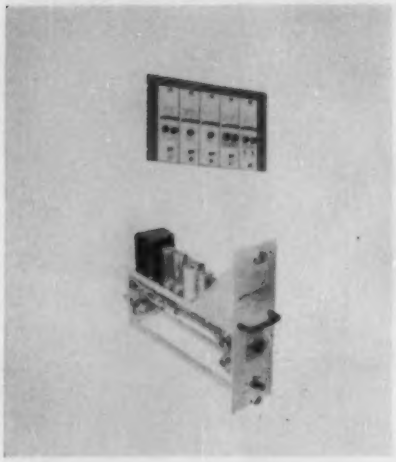
It costs you nothing to get expert advice on your magnetic conveying problems through Homer's recommendations—get the complete Homer "Space Saver" Magnetic Conveyor story today . . . Remember, Homer backs up its "Space Saver" recommendations . . . to your satisfaction.

Send for bulletin MC-250 which describes and explains the Homer "Space Saver" Magnetic Conveyor line.

THE HOMER MANUFACTURING CO., INC.
DEPT. 286 **LIMA, OHIO**

HOMER FIRST IN INDUSTRIAL PERMANENT MAGNETIC CONVEYORS

Circle 577 on Inquiry Card

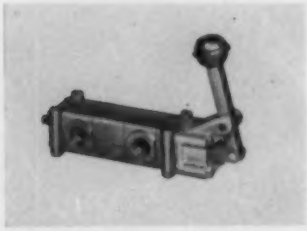


for industrial control, problem solving for both equations and control system design and data processing. Among units suitable for data processing are: Model 2315 modulator which modulates a dc control system with a 300 to 2000 cps carrier. The dc input is ±5 v rms for an ac phase sensitive output of ±5 v rms. Model 2317 tachometer unit modulates dc signals to modulated 400 cycle signals. It may be used to introduce stabilizing signals from dc tachometers into ac servo loops. Model 2306, a bridge type 400 cycle demodulator, converts the modulated carrier signal into the dc signal required by dc corrective or equalizing networks. With model 2316 corrective network derivative and integral control networks are rapidly assembled to shape the transmission characteristics of a dc servo loop or, with 2315 and 2306 for ac loops. Units are available as automation building block arrays or as specially packaged units to meet the demands of limited space or restricting ambients. **Servo Corp. of America,** 20-20 Jericho Turnpike, New Hyde Park, L.I., N.Y.

Circle 455 on Inquiry Card

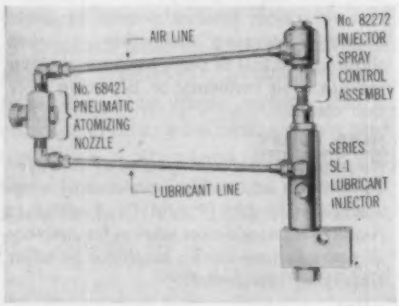
Tiny Air Valve

Designed for use as directional valve, interlocking valve, transfer valve or shut-off valve in pneumatic control systems with pressures as high as 250 psi and temperatures as high as 200F, ¼-inch valve features tiny size. New valve has the advantage of being able to be used in a system where not as much air is needed and where the amount of space that can accommodate a valve is limited. The ¼-inch valve can also be used as a remote control for a system using larger quantities of air. Its sectionalized construction permits over 3000 different two, three and four-way valves to be assembled from a few basic parts. Three and four-way valves are built with open exhaust and with



tapped exhaust ports. Sectionalized construction also permits each port, each end section and each operator of each one of the 3000 possible valves to be rotated in 90-degree steps through 360 degrees. **Westinghouse Air Brake Co., Industrial Products Div.,** Wilmerding, Pa.

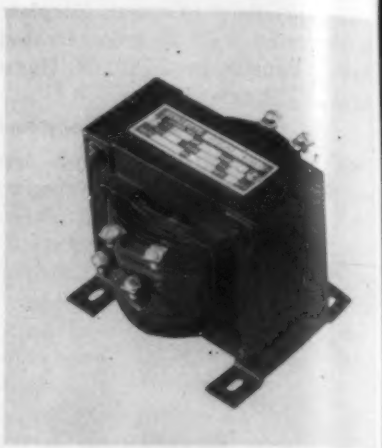
Circle 456 on Inquiry Card



Mist Lubrication Device

Automatic application of a controlled, premeasured quantity of mist lubrication on open gears, chain, cams, rollers, eccentrics, slides and ways, circular saws and similar surfaces is provided by MistOmatic spray control. Designed for use in conjunction with company power operated, time clock controlled, centralized lubrication systems, the control combination permits automatic, simultaneous lubrication of both closed bearings and open surfaces at preset time intervals. Valves provide positive, uniform automatic lubrication without waste. They eliminate spoilage from drippage of excessive lubricant and conserve man hours. **Lincoln Engineering Co.,** Industrial Div., 5794 Natural Bridge Ave., St. Louis 20, Mo.

Circle 457 on Inquiry Card

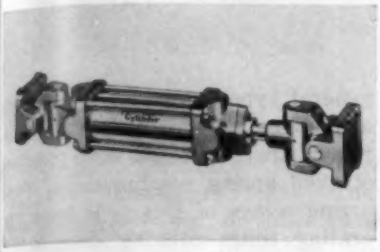


Saturable Reactor

Developed for applications where the degree of linearity and harmonic distortion of the load current is important, new saturable reactor can be designed to provide almost any load current waveform including sinusoidal waveform. Multi-unit saturable reactor can be used as a controller for the flow of active or reactive power to a load for applications where conventional saturable reactors are not suitable because of waveform. Reactor can be built for single phase and polyphase systems. Three phase unit is designed for a maximum reactor phase voltage of 220v and a reactor phase current of 4 amp. The reactor consists of twelve identical units, each of which (pictured) has three ac windings and one dc winding per core. The poly-unit saturable reactors are built from transformer type cores and materials. The power rating of the complete poly-unit reactor is of the order of the net transformer power ratings of the assembled units. Applications of the reactors include their use as single and polyphase adjustable load reactors for test purposes, for shunt reactor control of reactive kva of static capacitor banks, for control of reactive kva on transmission lines or high voltage cables, for single and polyphase line voltage regulators, and for the control of

power flow to loads where the maintenance of sinusoidal waveform is important. **Hevi Duty Electric Co.**, Milwaukee 1, Wis.

Circle 458 on Inquiry Card



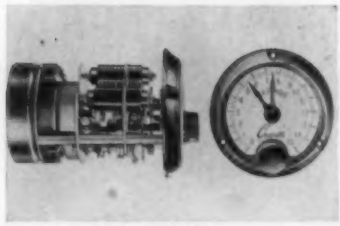
Cylinder Mountings

Designed for use in the operation of hopper gates, elements rotating about shafts such as gear segments and levers, and objects moving on wheels or tracks such as trucks or transfer tables, two new types of universal cylinder mountings eliminate problems due to misalignment between cylinders and their loads, thereby reducing costs associated with breakage of mechanical devices and cylinders. Mountings also compensate for deflection and misalignment where cylinders are connected to structures that are riveted, bolted or welded together. Universal mountings are available in two forms: Hinge mount cylinder with universal mounting brackets at each end (illustrated), and a cylinder with universal trunnion and universal mounting bracket for rod end. **Hanna Engineering Works**, 1765 N. Elston Ave., Chicago 22, Ill.

Circle 459 on Inquiry Card

Time Delay Relays

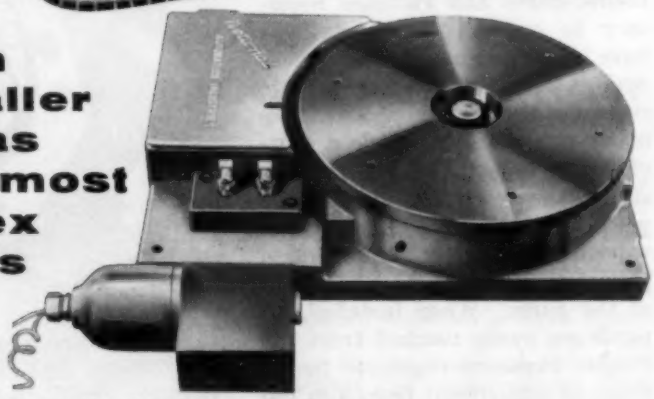
Two new time delay relays, Types 412 and 422, feature high accuracy operation. Both instruments are capable of maintaining repeat accuracy with $\pm\frac{1}{4}$ of 1 per cent of full scale (30 second and longer ranges) or $\pm\frac{1}{2}$ of 1 per cent on faster ranges. Additional features are white on black dial with 300-degree scale, allowing fast, precise settings and easy reading, with dial and pointer protected by transparent cover. Silver cadmium contacts rated at 15 amp have quick make, quick break wiping action and are of larger size than previously used, with ample capacity for high inrush currents. Nine-position terminal block permits easier wiring from side or back with a wider range of circuit possibilities than previously available. Friction setting mechanism allows adjustment while timer is operating. Type 412 timer automatically resets on power failure and begins a complete new cycle when service is restored. Type 422 timer includes a special reverse action clutch which causes it to suspend operation in case of power interruption, resuming and completing the same cycle when service is restored. **R. W. Cramer Co.**, Centerbrook, Conn.



Circle 460 on Inquiry Card

NEW compact index fixture!

fits in smaller areas than most index tables



it's a new, hydraulic-electrical, index fixture.
It's hydraulically operated and electrically controlled. It can be synchronized with the automatic cycling of your machine.

designed for many uses with tool room accuracy.
It can be used for gaging, grinding, milling, broaching, boring, drilling, honing, checking, staking and assembly operations.

no gears—no cams—no mechanical pawls!
And, no bang or shock, because the hydraulic cylinders provide a smooth action, and eliminate back lash. It's all hydraulic!

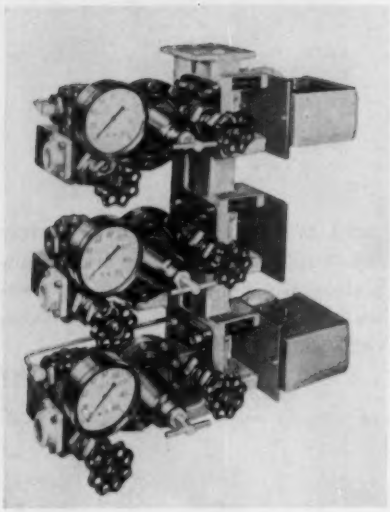
positions on any index, from 3 to 120!
And, guaranteed to .0003 tolerance, on a 12" gaging diameter.

and, it's really compact in design!
Even though the sub base is only 4¼" x 15" x 21¾", the table top is guaranteed flat and parallel, within .0001 of an inch. This table can be used with adapter plate as shown or four way valve.

Attractive territories now available.

AUTOMATION MANUFACTURING CORPORATION
8070 Wheeler Ave.
Detroit 10, Michigan

Circle 578 on Inquiry Card



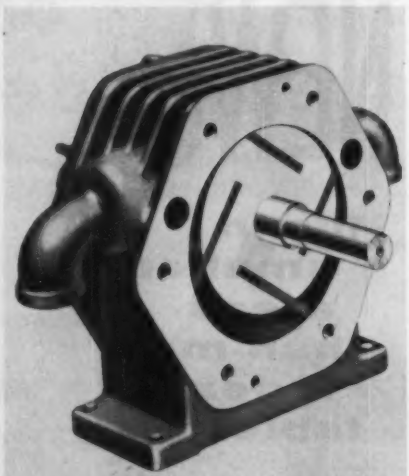
Press Air Manifold

A means of regulating the air supply to a clutch and brake unit, counterbalance cylinders and die cushions is provided by press air manifolds. All the valves, regulators, gages and switches necessary to operate these manifolds have been combined into one package. A single composite air valve regulates the supply of air. Elements of the valve include a shut-off valve, pressure regulator, pressure gage with needle throttle valve, check valve and exhaust valve. There is no intermediate piping to be done between each of the parts. When installed, all parts are easily reached from the front. Pressure regulator has a range of adjustment from 0 to 160 psi. New header brings together into one package as many composite air valves and pressure switches as are required for a complete press control. Headers provide flanges for mounting both the air valve and the air pressure switches. Headers are designed so that when the air manifold is bolted to the header, connections are made to both the air inlet and the exhaust simultaneously. Only connections necessary for installing the complete manifold assembly are one inlet and one exhaust line. Headers are furnished in either two or three-station sizes. They are provided with flanges so that larger assemblies of four or more stations can be bolted together. **Clearing Machine Corp.**, 6499 W. 65th St., Chicago 38, Ill.

Circle 461 on Inquiry Card

Bronze Rotary Pump

Designed for vacuum and/or pressure applications in handling steam, hydrogen, natural or manufactured gas, nitrogen or other inert gases carrying entrained moisture, corrosion resistant bronze rotary pump features vanes which require no lubrication in riding against the cylinder wall. Thus, the pump never has to be lubricated and no oil is present to get into the gas stream. Being of the rotary type, there is no reciprocating motion and the pump is pulseless and vibrationless, delivering an even flow of air and eliminating the need for surge tanks. Cylinder walls and end plates are precision ground to insure perfect fit and

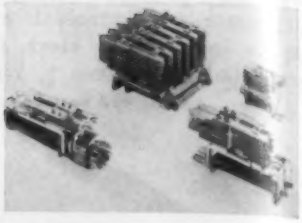


the balanced rotor is suspended on two double-sealed, grease packed lifetime ball bearings. The Dexter-Conde bronze pump is available in three models. Capacities range from 3.5 to 33 cfm and maximum continuous pressure is 20 psi. Maximum steady vacuum is to 20-inch Hg and maximum intermittent vacuum is 25-inch Hg. Pump is available with either single or double shaft extensions and may be furnished for either clockwise or counterclockwise rotation. **Dexter Folder Co.**, Pearl River, N. Y.

Circle 462 on Inquiry Card

Industrial Relays

Formerly used to give reliable service in telephony, line of relays is available for industrial applications. Relays are available in six



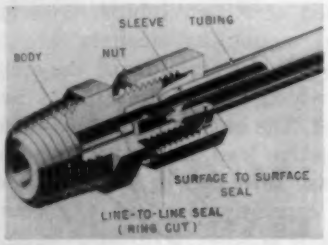
general types, most of them with a number of variations. Type A relays are single-coil with double-stacked spring combinations. Fast acting relays of this type have operating times ranging from 0.008 to 0.020-second, and release times of the same order. Type A relays can be supplied with one or two snap action switches or with one snap action switch and one spring pile-up. Relay-rectifier combinations provide the operating and physical characteristics of Type A dc relay with operation by 110 v ac through use of a compact selenium rectifier. All Type A relays also can be supplied with plug-in connections of the radio type, for use with commercial radio type sockets with eight, nine, 12 or 20 connections. Type B relays are gang-type relays with up to 60 Form A contacts. They are supplied with one or two coils, as determined by load requirements. Type C relays are essentially two relays mounted on a common frame, so that one Type C relay can be mounted in the same space as a Type A relay. Type D relays have been designed for use where a small, lightweight shock resistant relay is required. They withstand shocks up to 50 g and, when energized, will remain operated under shocks of 20 g. Types 3A and 3B relays are vibrating reed types, for providing ac current from a dc source. Relays can be used in conjunction with slow release relays to produce extended relay release, or they can be wired in self-interrupting circuits to produce time pulses. Type 340 relays are double-coil polar relays of the permanent magnet type. They are extremely sensitive to low currents, and are generally used for reverse battery supervision and signaling. Coils on the Type 349 relays are double-wound, and thus this type can be used for high-low supervision. **Stromberg-Carlson Co., Div., General Dynamics Corp.**, Rochester 3, N. Y.

Circle 463 on Inquiry Card

Four-Way Valve

Designed for farm and road building machinery and truck mounted equipment, C series valves feature four-way operation and heavy duty construction. For units up to 20 gpm, the valves feature a built-in pressure relief on the tank side, allowing tamper proof settings. Direct mounting on reservoir permits return ports to feed back directly to reservoir, eliminating return lines. **Wisconsin Hydraulics Inc.**, 3165 N. 30th St., Milwaukee 16, Wis.

Circle 464 on Inquiry Card



Tube Fitting

Suited for instrumentation and all other low and medium pressure applications using copper and aluminum tubing, self-aligning tube fitting is called the Selfalign. Advantage of this fitting is that it can be installed without disassembling. Tubing is simply inserted in the fitting until it bottoms and the nut is tightened. Dual sealing principle assures positive, leakproof connections. Sleeve grips the tubing over a broad area for a surface to surface seal, while a thin razor edge and guiding shoulder form a line to line seal with the tubing as the nut is tightened. Sizes ⅛, 3/16, ¼, 5/16, ⅜ and ½-inch in brass are available; aluminum fittings are special to order. **Weatherhead Co., Fort Wayne Div.**, 128 W. Washington, Fort Wayne, Ind.

Circle 465 on Inquiry Card

Binks Automatic Spindle Machine

Speeds output 400%
...coats 2000 pens an hour

This well-known company installed the Binks Automatic Spindle machine illustrated above to speed up the finishing of pens. Now they wonder how they ever got along without it.

This one machine enabled the company to increase production by 400%. Before its installation about 500 pens were finished per hour... now, with the aid of this automatic spray painting machine, 2000 lustrous pens are turned out in the same time...and rejects are reduced to a minimum.

Automatic spraying is better, faster

The speed, economy and quality of finish obtained with Binks automatic spray painting machines make them the answer to lower manufacturing costs. *Binks Automatic Spindle Machines* spray round or many-sided objects; *Binks Automatic Vertical Reciprocating Machines* spray flat objects suspended from overhead conveyors; *Binks Automatic Horizontal Reciprocating Machines* or *Binks Rotary Spray Machines* spray objects lying flat on horizontal conveyors. Almost any mass-produced product manufactured today can be finished or coated...better, faster and more economically...with Binks automatic finishing equipment.

For free engineering help, let a Binks Engineer analyze your finishing set-up. At no cost or obligation he will show you how you can save time, money and materials through automatic finishing.

Ask about our spray-painting school. Open to all...no tuition... covers all phases.

633

Binks
EVERYTHING FOR SPRAY PAINTING

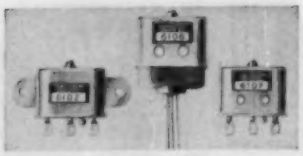
GUNS

SPRAY BOOTHS

COMPRESSORS

Binks Manufacturing Company
3132-40 Carroll Ave., Chicago 12, Ill.
REPRESENTATIVES IN PRINCIPAL U.S. & CANADIAN CITIES • SEE YOUR CLASSIFIED DIRECTORY

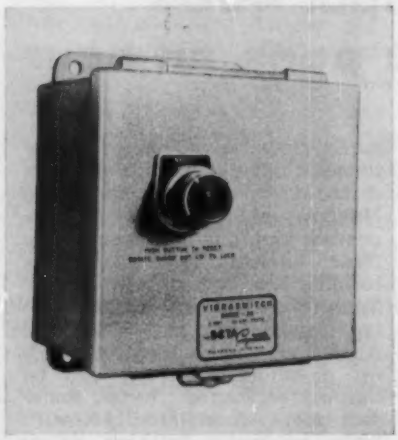
Circle 579 on Inquiry Card



Tiny Snap Switches

Designed to solve many limited space, minimum weight design problems where moisture, dirt, heat, cold and other environmental conditions might cause contact failure, 6100 series subminiature snap switches are dry gas filled, hermetically sealed, single-pole, double-throw units. Rated 5 amp resistive, 3 amp inductive, 2 amp motor load, either 28 v dc or 110 v ac, switches have electrical and mechanical life of 100,000 cycles. New series is available with either bracket or through-hole mounting, plus potted lead wires for 250F. **Haydon Switch Inc.**, 536 S. Leonard St., Waterbury 20, Conn.

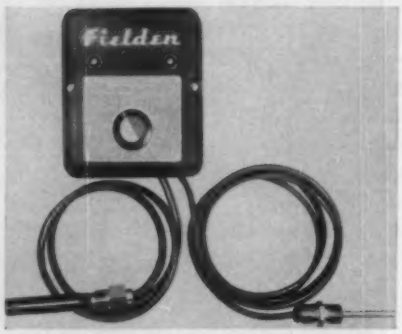
Circle 466 on Inquiry Card



Mechanical Detector

Designed for use in rotating or reciprocating equipment, new mechanical malfunction detector in an oiltight J.I.C. enclosure monitors vibration and actuates an alarm or causes shutdown when trouble occurs. It is used to detect malfunctions such as bearing roughness, unbalance, broken blades, bent shafts, etc. Mechanism is fail-safe, does not depend on external power source and requires no maintenance. Range of adjustment of 0 to 20 g provides for a wide range of normal vibration. Contacts are single-pole, double-throw, and rated at 5 amp, 115 to 230 v ac, resistive or inductive loads. Unit is mounted in an oiltight housing with an external reset and locking mechanism. It is suitable for mounting on equipment in almost any environment except hazardous locations. **Beta Corp.**, Forest Ave. at Ridge Rd., Richmond 26, Va.

Circle 467 on Inquiry Card



Solution Controller

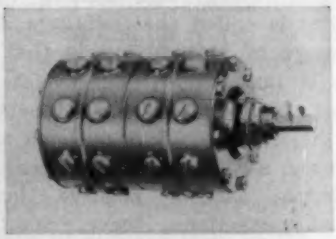
Electronic instrument for controlling the conductivity of solutions finds application in the water treatment, chemical, nuclear energy, power and metal processing industries, where it can be employed in controlling water purity, presence of specific chemicals in solutions, process baths, etc. Designed for simplified use and operation, the controller is equipped with two-zone action for both alarm and control. A single set point knob on the front provides control within the range of the instrument calibration. Scale calibration is nonlinear and provides maximum readability at high specific conductivities. Accuracy of the instrument is ± 0.5 per cent of full scale, and it has a sensitivity of ± 0.1 per cent of full scale, exclusive of the cell and temperature compensator. In solution temperature changes between 20 and 100F, automatic temperature compensation limits the maximum error to ± 2 per cent or ± 5 per cent of full scale. Controller is available with various types of conductivity cells, depending upon the application. Standard compensating bulb is provided with a 316 stainless steel sheath. **Fielden Instrument Div., Robertshaw-Fulton Controls Co.**, 2920 N. Fourth St., Philadelphia 33, Pa.

Circle 468 on Inquiry Card

Tachometer Generator

Miniature 115 v ac tachometer generator which operates on 60 cycles is especially designed to make a high performance unit available for industrial applications. Tachometer generator has been developed for use as the feedback element in closed looped servo circuits, and for industrial applications. It can be integrally coupled to Diehl instrument servomotors having outputs of 1, 5 or 10 w. Unit can be used to regulate the speed of a servomotor. With integral mount, backlash is zero, improving the stability of the system in which the tachometer is being used. The output, with 100,000 ohm resistive load, is 6 v per 1000 rpm. Phase shift can be brought to zero by capacitive load at any desired speed; maximum variation in phase shift between 0 and 3600 rpm is 3 degrees. Residual voltage is 100 milliwatts maximum. **Diehl Mfg. Co.**, Finderne Plant, Somerville, N. J.

Circle 469 on Inquiry Card

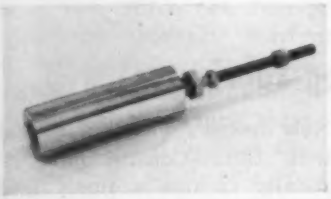


Rotary Switch

Designed for heavy duty service in selecting main power feeders, two to eight-position rotary switch features reliable performance. The operating principle involves the use of a spring loaded, spring actuated roller contact which seats in a stationary contact groove. Additional

spring pressure and mechanical linkage force the roller from the contact groove with high acceleration, causing a very fast break, and driving the roller at high speed to the next contact. The high pressure and high speed of the roller result in minimum arc. Since the arc occurs away from the static position, switch life and capacity are greatly increased. Switch may be ganged up to three sections, allowing as many as 24 separate isolated circuits. **Mason Electric Corp.**, 3839 Verdugo Rd., Los Angeles, Calif.

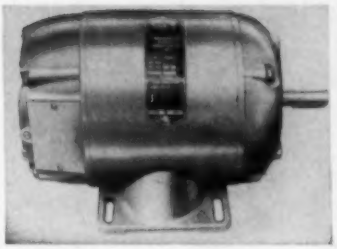
Circle 470 on Inquiry Card



Hydraulic Cylinder

Used in hand mills, cross slides, abrasive cut-off saws, etc., new hydraulic control cylinders help to convert manual machines into completely automatic, air hydraulic operation. Used in Rotafeed air-hydraulic drill units for several years, the unit, called the Hydro-Feed, when attached to any air cylinder, makes available 0 to 4-inch of rapid approach with infinitely variable feed in one direction and rapid return in the other direction. Maximum checking capacity is 3000 lb. Longer strokes and larger capacities are available on order. Basic unit has a microhoned 2-inch bore and 4-inch hydraulic feed. Unit is easily installed by mounting nose through a ⅞-inch hole and tightening nut. One of the features of the completely sealed-in unit which requires no make-up fluid or expansion chambers, is the method of feed adjustment. Simply turning the piston rod clockwise or counterclockwise by hand gives infinitely variable feed. Length of rapid approach is easily varied by running the two check nuts up or down the threaded rod. **Rotafeed Co.**, 2826 E. Grand Blvd., Detroit 11, Mich.

Circle 471 on Inquiry Card

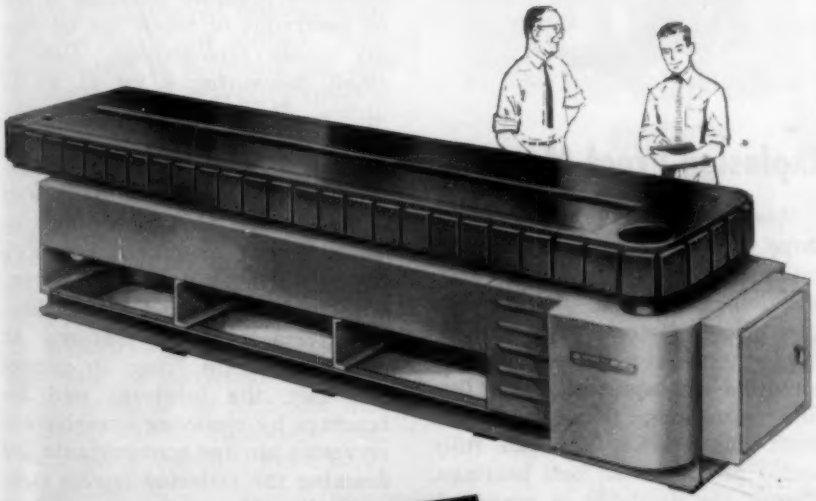


Slip Ring Motors

Used on printing presses, conveyors, ventilating equipment cranes and hoists, and other machines that require operator regulated running speeds, fractional horsepower slip ring motors feature variable speed and step by step starting. Example of the motor's versatility is the starting of a heavy load on regular low line current. High starting torque is provided by starting in a slow-speed step, full speed being attained through a series of steps. Motors are available as standard units in fractional ratings of ¼, 1/3, ½ and ¾ hp and are of the #66 frame size. **Reuland Electric Co.**, Alhambra, Calif.

Circle 472 on Inquiry Card

Plan your Special Purpose Machines
AROUND SWANSON STANDARD INDEXING MACHINE CHASSIS



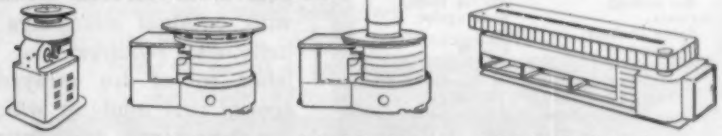
These standard units offer you a basic chassis for a wide range of special purpose and automatic machines. They give you substantial savings in cost *and eliminate much of your engineering time.*

Write for Bulletin 356J. It describes the complete line of Swanson Standard Index Machine Chassis, and shows how they help to reduce the cost of your automation program.

SWANSON TOOL & MACHINE PRODUCTS, INC. · ERIE, PA.

ENGINEERS AND BUILDERS OF AUTOMATIC AND SPECIAL PURPOSE MACHINES SINCE 1919

OVER 200 STANDARD MODELS



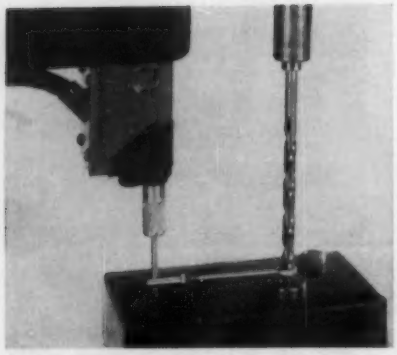
Series B & C Turret Index Models—for medium and light applications.

Series H Turret Index Models—for heavy duty applications.

Series K Turret Index Models—for heavy duty applications with center column tool mounting.

Series L Auto-Trac Straight Line Indexing Chassis—for automatic or semi-automatic assembly and processing operations.

Circle 580 on Inquiry Card



Broken Drill Detector

Designed to combat the problems incurred in multistation automatic machinery through breaking of a drill, new device is called the Broken Drill Detector. Unit is mounted adjacent to the drill and upon breakage of that drill, immediately after the drill head is retracted, a signal is lighted on the control panel, and the indexing or transfer motion is stopped until the defective drill is replaced. Model #100 is a unit installed directly on the drill head and travels with it. The drill probe encircles the drill and is in contact with it. This contact holds the telescopic section away from the drill with a slight pressure, shifting contacts in the switch assembly, holding the control circuit closed. The unit has a telescopic action which collapses while the drill enters the work and which extends itself while the drill head retracts. If the drill is broken, the drill probe is released and the switch contacts are shifted. This actuation stops the next cycle or transfer, also lighting a signal on the control panel indicating which drill is defective. Model #200 (illustrated) is installed on a static portion of the machine, rather than on the moving drill head. In many instances this is possible where the drilling unit merely moves through its drilling length and does not retract to an appreciable distance. Since the unit is statically mounted, no telescoping action is needed. All units are rated at 15 amp, 125 v ac, ½ amp, 125 v dc, and are supplied with 3 ft of three-wire type SO or ST cable. **Progressive Automation Controls Inc.,** 11601 E. Jefferson Ave., Detroit 14, Mich.

Circle 473 on Inquiry Card

New PRESET COUNTER by FREED

MODEL 2020

The Freed Model 2020 Preset Counter is designed for low cost reliable counting applications, where accuracy and maintenance-free operation is required.

Cold cathode counting and trigger tubes, with simplified circuits, are used throughout which assure years of trouble-free counting service and low-power consumption.

Model 2020 is a 4-digit single preset counter capable of controlling any operation that is repeated up to 9,999 times. Any number from 1 to 9,999 may be preset on the 4-digit selector switches. When the preset total has been reached, the counter will provide an output pulse and close contacts on a relay. These outputs may be used simultaneously or separately to stop machines, actuate control signals, or trigger additional equipment.

SPECIFICATIONS

Maximum Count: Four digits — 9,999	Pulse output 50 volts
Maximum counting rate: 300,000 counts per minute	Size: 8 x 6 x 12 inches
Input Sensitivity and Waveform: Not critical	Weight: 11 pounds
Outputs: Relay contact 10 Amperes	Power: 25 watts 105-125 volts, 50-60 cycles
	Price: $425.00

Freed also manufactures Totalizing, Preset, and Batching Counters

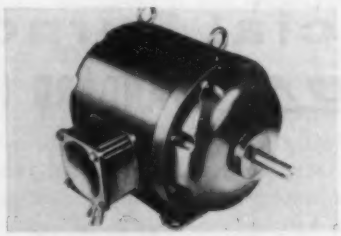
SEND FOR COMPLETE INFORMATION

Engineering assistance available for adapting these counters to your specific applications.

FREED TRANSFORMER CO., INC.

1705 Weirfield Street
Brooklyn (Ridgewood) 27, N. Y.

Circle 581 on Inquiry Card



Explosion Proof Motors

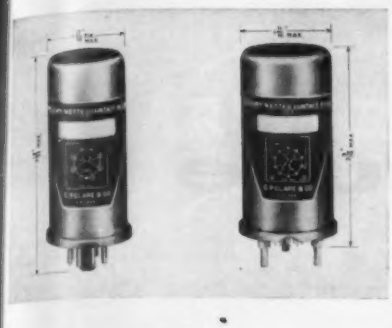
Meeting the requirements for three most common hazardous locations—gaseous, explosive dust, and explosive grain dust—explosion proof motors are specially treated to resist moisture, dust and corrosive atmospheres. Units feature extra-long flame paths at shaft and bracket fits and fully sealed prelubricated ball bearings. Motors are available in standard, geared, or variable speed models, with optional mountings to meet individual requirements. The finished rotors are sprayed with a special rust inhibitor which covers the rotor and the entire shaft. Brackets and terminal boxes are carefully cleaned and given an anticorrosion primer—a combination of zinc chromate and iron oxide. **Sterling Electric Motors Inc.,** 5401 Telegraph Rd., Los Angeles 22, Calif.

Circle 474 on Inquiry Card

Fog Lubricator

New device for centralized lubrication, Lubro-Control unit, automatically creates a finely divided airborne oil fog which can be uniformly distributed through complex piping systems to multiple lubrication points. A single unit can completely lubricate even the largest machines, up to 1000 bearing-inches. Two pressure switches and a float controlled switch are provided for connection to a control panel, if desired, to actuate an automatic alarm system or controls when air pressure fails, when excessive pressure develops in the oil reservoir, or when the oil supply needs replenishing. Unit is small, measuring 9 by 11 by 12 inches. It contains all necessary controls plus a 2-gal oil reservoir —enough oil for 12 hours lubrication at maximum output. Unit eliminates the need for multiple installations of many smaller lubricators which would involve numerous check points and maintenance operations. Device features an automatic drain filter to protect the unit, the lubricant and the bearings by removing abrasive and corrosive air line contaminants and draining the collected liquids automatically. Air pressure is accurately regulated to provide the most efficient lubrication. A solenoid valve co-ordinates operation of the lubricator with the starting and stopping of the machine. **C. A. Norgren Co.,** 3499 S. Elati, Englewood, Colo.

Circle 475 on Inquiry Card



Contact Relays

Capable of reliably switching contact loads from microwatts to ¼ kilowatt for over a billion operations, multielement, mercury-wetted contact relays are available in two, three and four-pole, double-throw contact configuration. Multipole construction is obtained by energizing with one coil, two, three or four magnetic switches identical to that used in the standard single-pole relays. Each magnetic switch is hermetically sealed in a hydrogen pressurized glass envelope. Contact surfaces are continually wetted with mercury by a capillary connection to a mercury reservoir. The high-speed, long life relay has low and consistent contact resistance, no contact bounce, and is maintenance free. Contact rating is maximum 5 amp or 500 v, maximum 250 va. Contact resistance is 40 milliohms or less, constant within 1 milliohm of original value over the life of the contact. Rate of operation is 60 cycles per second maximum. Operating speed is 5 milliseconds at 2 w coil input. Relays are used for switching microsecond pulses, magnetic drum memories, thermocouples, or for numerous low-level circuits. Two basic assemblies are illustrated. The smaller is for two or three-pole relay with octal plug base for two-pole and 11-pin octal style base plug for three-pole. The larger enclosure is for four-pole with standard 14-pin miniature plug. **C. P. Clare & Co.**, 3101 Pratt Blvd., Chicago 45, Ill.

Circle 476 on Inquiry Card

Plating Cycle Control

Separate, automatic plating cycle control for each tank in production barrel plating plants is achieved with new control unit. A control box having two signal lights and an automatic cut-off time switch comprise the new system. Installation is made easily and quickly by removing the cathode bar from each tank and replacing it with the Hoffman control box. The cut-off time switch may be mounted on the front of each tank or near it to suit the convenience of the operator. The operator starts the current flow and the plating cycle by presetting the time on the switch dial. During the plating cycle, the green light on the control box is on. It goes off upon completion of the cycle and the red signal light goes on. The red light signals the end of the plating cycle and shows that the current has automatically been cut off. Controls permit visual check on each tank or on the operation of the entire plant. Safe removal of each tank barrel without danger of arc-started hydrogen explosions is possible through use of these controls. Since the current can be turned off at will on each tank, burning and unnecessary corrosion of barrel contacting points and the splashing of electrolytic

solutions no longer occur. The contactor closes its contact at a voltage which will not exceed 9.5 v throughout a temperature range of −50 to 160F. At room temperature the closing voltage is approximately 7 v. Contacts will reopen either when the voltage is removed entirely, or when the voltage is reduced to less than 5 v. Unit is rated for 600 amp at 12 v. **Hoffman Control Co.**, 6804 Park Ave., Cleveland, O.

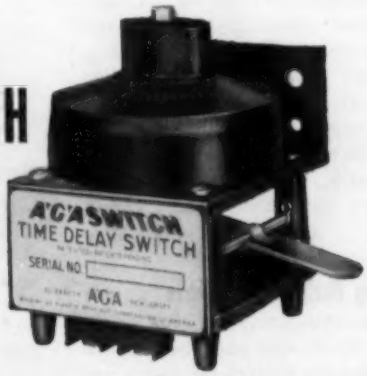
Circle 477 on Inquiry Card

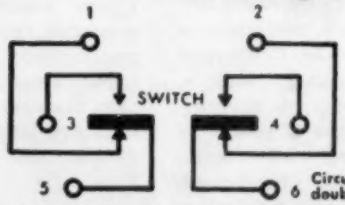
NEW!

AGASWITCH

TRADEMARK

...to introduce time delays into electrical circuits





Circuit diagram, double pole unit

- Adjustable—time delays from 0.1 second to 5 or more minutes
- Manually operated, pneumatically timed
- Only 3½" x 2½" x 2½" overall
- Both single and double pole types
- Accurate, adaptable, compact and inexpensive

Write for details or application engineering assistance. Address Dept. A6-723.

A'G'A DIVISION ELASTIC STOP NUT CORPORATION OF AMERICA
1027 Newark Avenue, Elizabeth, New Jersey
Pioneers in pneumatic timing

Circle 582 on Inquiry Card

catalogs and literature

Latest automation information. For copies use card page 17.

Automatic Drilling Equipment

Dumore Precision Tools, Racine, Wis. — 24-*page booklet* — Evaluating the basic drill unit requirements for automatic drilling, tapping, reaming and related operations is discussed in Catalog No. 55-D. Automatic drill units and drill heads, and small diameter drill grinder are illustrated and described, with their specifications and illustrated applications given. Accessories and attachments for the drilling equipment are also pictured.

Circle 478 on Inquiry Card

Welding Machinery

Acro Welder Mfg. Co., Milwaukee 3, *Wis.*—12-*page bulletin* — Single and multihead semiautomatic and fully automatic resistance welding machinery is the subject of bulletin 156. Automatic wire welding, forming and cutting machine; gun spot welder; can welder; mill type production welder; dial feed welder and shell seam welder are among special resistance welders shown. Special arc welders and standard resistance welders are also illustrated.

Circle 479 on Inquiry Card

Conveying Bulk Materials

Ajax Flexible Coupling Co., Inc., Westfield, N. Y.—16-*page booklet* — Line of vibrating conveyors which are designed to handle bulk materials is the subject of Bulletin 39. Conveyors are comprised of a pan or tube, a self-contained vibrating or shaking mechanism and a source of power to operate the vibrating drive unit. Photographs illustrate equipment used in food, chemical, foundry, abrasive, and ceramic industries. Open and closed pan and tubular models are also pictured.

Circle 480 on Inquiry Card

Selenium Rectifiers

Federal Telephone & Radio Co., 100 *Kingsland Rd., Clifton, N. J.*—8-*page bulletin*—Designed for use in printed circuitry, line of selenium rectifiers described in Information Bulletin M1 has applications in radio, television, phonograph, recorder and industrial equipment. Physical and electrical characteristics are given in chart form, with diagrams giving the dimensions of each type of rectifier.

Circle 481 on Inquiry Card

Controllers and Regulators

Moore Products Co., H & Lycoming Sts., Philadelphia 24, *Pa.*—14-*page booklet* — Instruments designed for various control and regulating applications are the subject of illustrated booklet. Derivative control units, liquid level controllers, scanning stations, purge flow controllers, ratio control stations, differential pressure transmitters, bubbling systems, pressure regulators, static pressure transmitters, relays, and valve positioners are covered. Ranges, model numbers and materials available in each instrument are included, along with photographs of various models.

Circle 482 on Inquiry Card

New Gearmotor Line

Reliance Electric & Engineering Co., 1088 *Ivanhoe Rd., Cleveland* 10, *O.*—8-*page bulletin*—"Reduce Speed" is the title of new bulletin E-2408 which describes line of gearmotors which incorporate NEMA motors and redesigned gearheads. Selection of types, mountings, enclosures, and available ratios is covered. Types of gearmotors, service, output speeds, horsepowers, electrical characteristics, enclosures and types of mountings are listed, with cutaway photographs and diagrams included.

Circle 483 on Inquiry Card

Gaging for Automation

Federal Products Corp., 1144 *Eddy St., Providence* 1, *R. I.* — 26-*page catalog*—Four gaging systems used for automatic control—electric, air-electric, electronic and air-electronic—and the components which comprise each system are discussed in catalog 56 AM. Various types of control gaging for automation, such as on-the-machine, after-the-machine, continuous process, etc. are also discussed. Advanced types of gaging control, including differential measurement, nonreference variation and combined gaging, are described. Photographs and specifications of numerous gaging components are given.

Circle 484 on Inquiry Card

Hydraulic Pumps & Fluid Motors

Kalamazoo Div., New York Air Brake Co., Kalamazoo, Mich.—16-*page booklet*—Application of fluid power to many types of industrial and mobile equipment is possible with line of hydraulic pumps and motors described in collection of pamphlets. Dual-vane pumps are used to provide a source of controlled fluid power for hydraulic presses, die casting and plastic molding machines, closing and clamping devices. Dual-vane fluid motors are designed for use in industrial and mobile circuits requiring frequent starting, stopping and reversing.

Circle 485 on Inquiry Card

Precision Blending

Bowser Inc., Fort Wayne, Ind.—12-*page bulletin* — Automatic system which is designed for accurately blending, compounding or mixing of lube oils, beverages, coolants, chemicals, liquid foods and other liquids is discussed in illustrated bulletin. Each ingredient processed through the system is continuously measured, recorded and controlled in exactly metered quantities. Installation sketch, typical wiring diagram and numerous photographs illustrate the bulletin.

Circle 486 on Inquiry Card

Multiple Rivet Setters

Chicago Rivet & Machine Co., 9600 *W. Jackson Blvd., Bellwood, Ill.*—8-*page bulletin*—Three types of rivet setters which are designed to reduce fastening costs are described in illustrated bulletin. A multiple setter with fixed riveting centers, a multiple set-

Circle 583 on Inquiry Card→

HARTFORD *Special*

COMPLETE DRILL UNIT LINE!

CONDENSED SPECS . . . 3 Models, 15 Drive Arrangements

Model No.	Drilling Capacity Mild Steel	Tapping Capacity Steel	Maximum Stroke	Horse Power	Spindle Speed Range	Feed Range	Rapid Approach Rate	Rapid Return Rate	Standard* Spindle Nose
19-150	7/16" dia.	3/8"	1½"	⅓ to ¾	300 rpm to 10,000 rpm	0-70 ipm	350 ipm	300 ipm	#2 Jacobs external taper
19-400	5/8" dia.	5/8"	4"	¾ to 2	100 rpm to 5,000 rpm	0-50 ipm	300 ipm	240 ipm	#2 Morse internal taper
19-600	1¼" dia.	1"	6"	1½ to 5	28 rpm to 3,450 rpm	0-180 ipm	Adj. to 300 ipm	Adj. to 240 ipm	#4 Morse internal taper

* Special spindles available on request.

If in your plant you drill, tap, ream, spot-face, center, hollow mill, chamfer or counter-sink and you want to cut costs, send for this catalog . . .

MACHINE TOOL DIVISION
THE HARTFORD SPECIAL MACHINERY CO.
2857 Homestead Avenue, Hartford 12, Conn.

☐ Have Field Engineer call.
☐ Send Application Data Sheet and descriptive Bulletin.

Name_____

Company_____

Street_____

City_____ Zone____ State_____

ter with adjustable riveting centers and a multiple setter with loading and indexing fixtures are pictured and briefly discussed.

Circle 487 on Inquiry Card

High Speed Indexing

Ferguson Machine & Tool Co. Inc., P. O. Box 5841, St. Louis 21, Mo.—24-page catalog—Designed to increase production speeds in new or existing equipment, line of drives for dial feeds, roll feeds and carrier and chain applications are the subject of catalog 106. Selection and application data, methods of calculating load requirements and load ratings are discussed. Standard packaged power unit for indexing straight line assembly machinery is introduced in the catalog.

Circle 488 on Inquiry Card

Pneumatic Speed Control

U. S. Electrical Motors Inc., Box 2058, Los Angeles 54, Calif.—8-page bulletin—Designed for use with Varidrive motors, pneumatic control which is called the Varitrol is described and discussed in bulletin 1882. Varitrol provides automatic means which permit the motor speed to be controlled by pressure, temperature, humidity, viscosity and other variables. Schematic diagrams, photographs, and typical control applications are included.

Circle 489 on Inquiry Card

AC Magnetic Starters

RBM Div., Essex Wire Corp., Logansport, Ind.—8-page bulletin—Used for starting and stopping ac squirrel cage motors, line voltage type ac magnetic starters are the subject of bulletin No. 1020. Enclosed starters are used for controlling pumps refrigeration and air compressors, conveyors and other motor operated machinery. Bulletin discusses reversing and nonreversing types, and thermal overload relays. A chart giving approximate full load ratings of ac motors is given as a selection guide.

Circle 490 on Inquiry Card

Automatic Marking Units

Dashew Business Machines Inc., Dept. 6, 5886 Smiley Dr., Culver City, Calif.—20-page booklet — Equipment for automated data processing on self-writing metal identification tags and their applications for linking office/factory systems to control production, storage, inventory, shipping and receiving are discussed in booklet entitled "6 Honest Serving Men." Corrosion resistant identification plates; automatic embossing machine which attaches tying wires, coats, embosses and notches plates; hand operated device which transcribes embossed data onto forms; and portable tool which uses identification plates for roll-on marking of either curved or flat surfaces are covered.

Circle 491 on Inquiry Card

Shock & Vibration Mountings

Robinson Aviation Inc., Teterboro, N. J.—8-page bulletin—Designed to provide smoother and quieter operation of machine tools and business equipment, all-metal shock and vibration control mountings are the subject of bulletin No. 1000. Illustrations, dimensions and load ranges of the mounts and their recommended applications are included, along with information on design factors such as attenuation of high or low frequencies, multiple machine operations, lateral forces, mounting of presses and drop hammers, etc.

Circle 492 on Inquiry Card

Remote Digital Weights

Toledo Scale Co., Toledo 1, O.—8-page bulletin—Developments which make possible the remote recording of weights in digital form are de-

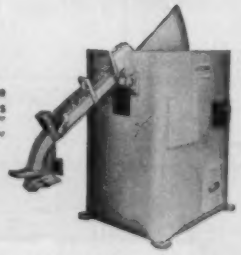
FEED PARTS AUTOMATICALLY

with FEEDALL FEEDERS

VIBRATORY Model for washers and small parts — high rate of feed.

← No. 2200 Elevating Feeder elevates cylindrical or sliding parts for automatic gravity feed.

No. 2000 Blade Feeder feeds parts up to 2" in dia. and 7" long.



Write for Catalog advising purposes for which you require automatic feeders.

FEEDALL INCORPORATED WILLOUGHBY, OHIO

Circle 584 on Inquiry Card

BECKETT Hi-CYCLIC

SOLENOID VALVE-PILOTED AIR VALVES

★ Full Pressure Piloted

¼" SIZE

MODEL BVP1—Single Solenoid less exhaust controls

$34.10

F.O.B. Wilmington, Ohio.

★ ⅛" to 1" sizes, single and double solenoid. High speed • Accurate control • Compact • Low current demand • Write for detailed information.

Look to Beckett for advanced design! A complete line—150 models—of air and hydraulic directional control valves ... *precision-built, economically priced!* Send for catalog.

BECKETT-HARCUM CO., INC.

1097 WAYNE ROAD, WILMINGTON, OHIO

Circle 585 on Inquiry Card

scribed in Form 2975. Remote weights can be automatically card punched for tabulation, listed and totalled on adding machines, indicated in digits, recorded on electric typewriters and tape punched for data storage. Photographs illustrate equipment used for remote recording of this type.

Circle 493 on Inquiry Card

Stroke and Revolution Counters

Production Instrument Co., 704-26 W. Jackson Blvd., Chicago 6, Ill.—8-page bulletin—Used in automobile and aircraft factories, metalworking, die casting and plastic molding plants, foundries and printing plants, line of counters are described in Catalog M 200. Count life ratings range from three million to one billion. Numerous models of stroke and revolution counters, wheel assemblies, gears and accessories are illustrated and described.

Circle 494 on Inquiry Card

Ceramic Transducers

Gulton Industries Inc., Metuchen, N. J.—12-page bulletin—Use of piezoelectric ceramic transducers is discussed in new bulletin. Applications of the transducers include ultrasonic, shock and vibration, medical and underwater sound equipment. Discussion of resonant frequency characteristics and tables outlining standard sizes and shapes of transducers are included. Also covered are complete physical and electrical properties and specifications for the ceramic materials.

Circle 495 on Inquiry Card

Industrial Signal Selection

Federal Sign & Signal Corp., Dept. PR, 8700 S. State St., Chicago 19, Ill.—8-page bulletin—The proper use of modern visual and audible signals for industrial manufacturing is the subject of Bulletin 100. Signal development, basic principles of sound, and signal planning are covered. Signal selector wheel serves as guide in selection of best signal for specific applications.

Circle 496 on Inquiry Card

Vibratory Parts Feeders

Perry Equipment & Engineering Co., Erie, Pa.—8-page bulletin—Parts are fed to assembly lines at predetermined rate by vibratory feeding equipment described in Catalog 356. Cast feeder bowls are designed to feed parts for metalworking, processing, packaging or assembly operations. Drive units and remote control panels for the feeders are illustrated and described; information on overhead hoppers and orientation track units is also included.

Circle 497 on Inquiry Card

Hydraulic Furnace Controls

Askania Regulator Co., 240 E. Ontario St., Chicago 11, Ill.—8-page bulletin—Jet-pipe regulators which are used for automatic combustion control, heat input control, and pressure control are illustrated in connection with automatic control of glass tank furnaces in bulletin 305. Photographs illustrate regulators operated by mechanical and electrical signals. Components and installation of the glass-making system are also covered.

Circle 498 on Inquiry Card

Automatic Assembly Machine

Multra Corp., Stamford, Conn.—12-page bulletin—Designed to assemble a variety of electrical, electronic and mechanical products, new 7000-lb machine is the subject of illustrated bulletin. Construction of the machine, part-by-part assembly of a single product, position of the tools and vibratory feeders around the work table, mechanical features, feedback system, electrical controls and overall size are graphically described and illustrated.

Circle 499 on Inquiry Card

Water Filtration Plants

Builders-Providence Inc., 345 Harris Ave., Providence, R. I.—16-page booklet — Line of instrumentation

"OUR PACKMASTER DOES IT
50 TIMES FASTER
at 1/9 THE COST"
REPORTS ONE AIRCRAFT MANUFACTURER

Field representatives in Los Angeles, California

Really saves money on small parts packaging. Packs, prints, counts . . . all on one compact machine needing less than 3' x 4' floor space. Simple to change from one size to another. Feeding table has place for as many as 3 operators for complex packs. Makes many government specified packages. Larger models available, too.

Write to:
PACKMASTER
SALES COMPANY
P. O. Box 3510
Akron 10, Ohio

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STAMPINGS

Produced economically in our modern plant for:

AUTOMOTIVE, INDUSTRIAL EQUIPMENT, DOMESTIC APPLIANCE, AGRICULTURAL INDUSTRIES AND OTHERS; will boost your output at material savings.

Our production, engineering and toolroom facilities are geared to the volume usage of your industry.

Send us your inquiries

LANSING STAMPING COMPANY
1157 So. Pennsylvania
Lansing 2, Michigan
Serving Industry Since 1914

Circle 587 on Inquiry Card

CATALOGS AND LITERATURE

equipment for the control of water treatment plants is discussed and illustrated in booklet 100-K2A. Primary elements for flow measurement, meter instruments, filter effluent rate controllers, wash water controllers, filter gages, automatically operated filters, plant control and chlorinization are among the topics covered.

Circle 500 on Inquiry Card

Precision Flame Machining

Seaman-Andwall Corp., Cogmatic Div., 305-9 N. 25th St., Milwaukee 1, Wis.—8-page bulletin—Patented process for producing large sprockets and gears automatically by means of precise control of a fast-cutting torch is the subject of illustrated bulletin. Principles and examples of flame machining for fabrication and typical applications of the flame machined sprockets and gears are covered.

Circle 501 on Inquiry Card

Can Machinery

E. W. Bliss Co., 50 Church St., New York 7, N. Y.—12-page bulletin—Automatic testers for round, square, oval and rectangular cans are described in Catalog 36B, Section 6. Five automatic models are illustrated and briefly discussed. Hand operated testers and detectors are also covered. Other company automatic can machinery includes slitters, strip feed presses, body makers, flangers and seamers.

Circle 502 on Inquiry Card

Pneumatic Machines and Valves

Beckett-Harcum Co., Inc., Wayne Rd., Wilmington, O.—72-page catalog—Drilling and tapping machines, air and hydraulic valves, and air powered automatic drill press feeds are described in comprehensive catalog. Specifications, features and parts list for complete line of valves are included. Photographs and information on air thrust drilling machine, drill press feeds and drilling-tapping models are given.

Circle 503 on Inquiry Card

Instrument Tubing Products

Dekoron Products Div., Samuel Moore & Co., Mantua, O.—4-page pamphlet—Line of plastic coated metal tubing is described and illustrated in Bulletin 456. Specifications of copper, aluminum and polyethylene tubing, and of plastic tubing are included. Six types of tubing are illustrated and briefly described.

Circle 504 on Inquiry Card

Precision Relays

Manning, Maxwell & Moore Inc., Industrial Controls Div., Stratford, Conn.—4-page pamphlet—Used for alarm signaling and *On-Off* operation of electrical loads, two types of precision relays are discussed in Bulletin MRM 240. Series 135R is used for high-limit action; series 135R-RO is for low-limit action. Design features, operating specifications and general dimensions are covered in the pamphlet.

Circle 505 on Inquiry Card

Dial Index Table

Gray Equipment Co., 13600 *Ford Rd., Dearborn, Mich.—4-page pamphlet*—Designed to automate assembly and machining operations, GEM-17 dial index table is the subject of illustrated pamphlet. Photograph illustrates table being used for automatically positioning valve housings for burnishing and chamfering. Performance characteristics and specifications are given.

Circle 506 on Inquiry Card

Automatic Sensing Devices

Richardson Scale Co., Van Houten Ave., Clifton, N. J.—2-page pamphlet—Lack of material supply or flow in a handling operation is indicated by automatic sensing devices described

NEW improved!

Clippard
Model No. MAC 385

MINIATURE
PNEUMATIC CYLINDER

...for MILLIONS of cycles of AUTOMATIC OPERATION!

While still the same size overall (2-3/16" x 7/16") the new improved Clippard Miniature Air Cylinder incorporates a number of improvements, assuring you of MILLIONS of trouble-free cycles of operation!

Stroke, for example, has been increased from ¾" to ½". Internal friction is reduced thru use of a special new self-lubricated synthetic piston ring. Cylinder case is rolled into knurled, grooved cylinder end at bottom so keyed shaft will never loosen or turn. Spring return has been improved and cylinder is cushioned internally to absorb shock. Will operate up to 800 cycles per minute.

For light AUTOMATIC or SEMI-AUTOMATIC work operations, you will find sturdy new Clippard MAC 385 Miniature Air Cylinders ideal, especially when used with our miniature Air Valves, Cam-follower Heads, Manifolds, Fittings and Accessories. Write, NOW, for power and static data, catalog sheet, complete specifications and modest prices!

DEALERS-DISTRIBUTORS: Write For Attractive NEW Sales Proposition

Clippard INSTRUMENT LABORATORY, INC.
7384-A Colerain Road, Cincinnati 24, Ohio
Manufacturers of R.F. Coils, Electronic Equipment, Miniature Pneumatic Devices

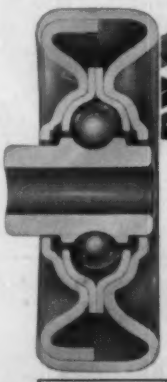
Circle 588 on Inquiry Card

METZGAR GRAVITY CONVEYORS

Life-time Construction

Means More for Your MONEY

Standard Sections
Wheel-Roller Widths
11½"; 15"; 18"
Lengths
8'; 10'
Curves
45° - 90°



16 YEAR'S Continuous Service

..at no maintenance cost because Metzgar carries the load on these sturdy bearings — ¼" steel balls (Hoover or equal) spinning in hardened labyrinth ball races.

Standard in all Metzgar wheel and roller gravity Conveyors.

Write for descriptive folder.

METZGAR CONVEYOR CO.
408 Douglas N.W.,
MFRS. OF WHEEL & ROLLER GRAVITY & LIVE ROLLER CONVEYORS • POWER BELT CONVEYORS • SWITCHES • ACCESSORIES
GRAND RAPIDS 4, MICH.

Circle 589 on Inquiry Card

in Technical Reference 55D. Units give warning by bell, horn, light or other suitable means when a lack of material supply or flow is detected in chutes, conveyors, bins, hoppers and silos. Three models are illustrated and described.

Circle 507 on Inquiry Card

Roll Cradle Machines

U.S. Tool Co. Inc., Ampere, N. J.—4-page pamphlet—Designed for easy and rapid coil loading either by hand or by overhead crane, new multiroll cradle machines are covered in pamphlet 95. Specifications and descriptions of three models are included, along with photograph showing design features.

Circle 508 on Inquiry Card

Liquid Coolant Chillers

Lundholm Mfg. Co., 1121 *Charles St., Rockford, Ill.—4-page pamphlet*—Use of large coolant reservoirs is eliminated by liquid coolant chillers described in Form 357-8-55. Photographs illustrate chiller attached to a double horizontal spindle disk grinder and to a piston ring grinder.

Circle 509 on Inquiry Card

Temperature Controllers

Minneapolis-Honeywell Regulator Co., Industrial Div., Wayne & Windrim Aves., Philadelphia 44, *Pa.—4-page pamphlet*—Available as a single-point controller, as a differential controller, or for cascade control, non-indicating temperature control device is the subject of Specification Sheet S1010-1. Specifications, control elements and high-speed resistance bulbs for use with the controllers are discussed.

Circle 510 on Inquiry Card

Heavy Duty Cylinders

Oilgear Co., 1585*D W. Pierce St., Milwaukee* 4, *Wis.—6-page pamphlet*—Designed for 1500 psi, 3500 psi or higher pressures, line of heavy duty cylinders is the subject of pamphlet 79000. Several styles of cylinders built for hydraulic presses, testing machines, billet scalping machines, automatic rail welders, and several other types of equipment are illustrated and briefly described.

Circle 511 on Inquiry Card

Voltage Converter Systems

Beckman Div., Beckman Instruments Inc., Fullerton, Calif.—6-page pamphlet—"Analog Measurement and Conversion to Digits" is the title of Reprint R-78. Pamphlet deals with analog-to-digital conversion by voltage converter systems, with principles of operation of three systems described.

Circle 512 on Inquiry Card

Strip Chart Printer

Royson Engineering Co., Hatboro, Pa.—4-page pamphlet—Identichart, new automatic device which prints identifying marks on strip charts from a remote point, is the subject of illustrated pamphlet. Identicharts show the time or sequence in which conditions occur during process, test or control work.

Circle 513 on Inquiry Card

Permanent Magnet Motors

Barber-Colman Co., Aircraft Controls Div., 1400 *Rock St., Rockford, Ill.—4-page pamphlet*—Designed for aircraft or industrial applications, line of fractional horsepower dc permanent magnet motors is the subject of Catalog F 4344-3. Also covered are gear heads, centrifugal blowers and tachometer generators.

Circle 514 on Inquiry Card

Rotary Actuator

Carter Controls Inc., 2800 *Bernice Rd., Lansing, Ill.—2-page pamphlet*—Reciprocating cylinder action is transformed into rotary motion by new rotary actuator described in pamphlet. Actuator may be powered with air, gas, water, oil and fluids of all kinds. Features, applications and cutaway diagram of the unit are included.

Circle 515 on Inquiry Card

Zenith AUTOMATIC CONTROLS

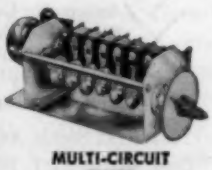
ARE ENGINEERED TO GIVE YOU GREATER ACCURACY!

Rely on field-proved ZENITH Controls for trouble-free, maintenance-free operation . . . long-lasting performance and accuracy.

INTERVAL TIMER

The ZENITH line includes: Magnetic Contactors; Remote Control Switches; Automatic Transfer Switches; Reset, Interval, Process and Impulse Timers; Program Clocks . . . and special units to order.

PROCESS TIMER



MULTI-CIRCUIT TIMER

Write Today for Latest ZENITH Bulletin

See classified telephone directory for name of local distributor

ZENITH ELECTRIC CO.

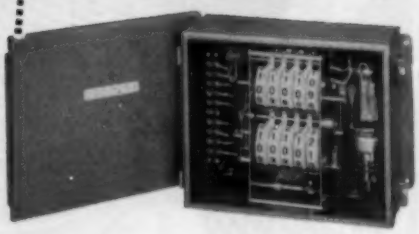
145 WEST WALTON STREET • CHICAGO 10, ILLINOIS

Circle 590 on Inquiry Card

BATCH COUNTER

Automatically controls number of Pieces To or From a Machine or packing operation, or on a conveyor.

Spencer BATCH COUNTER



- Easily pre-set to any number from 1 to 99,999.
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- As impulses are received, one counter subtracts from pre-determined figure—the other adds. When pre-determined figure is reached, control function is performed and counting operation is repeated.
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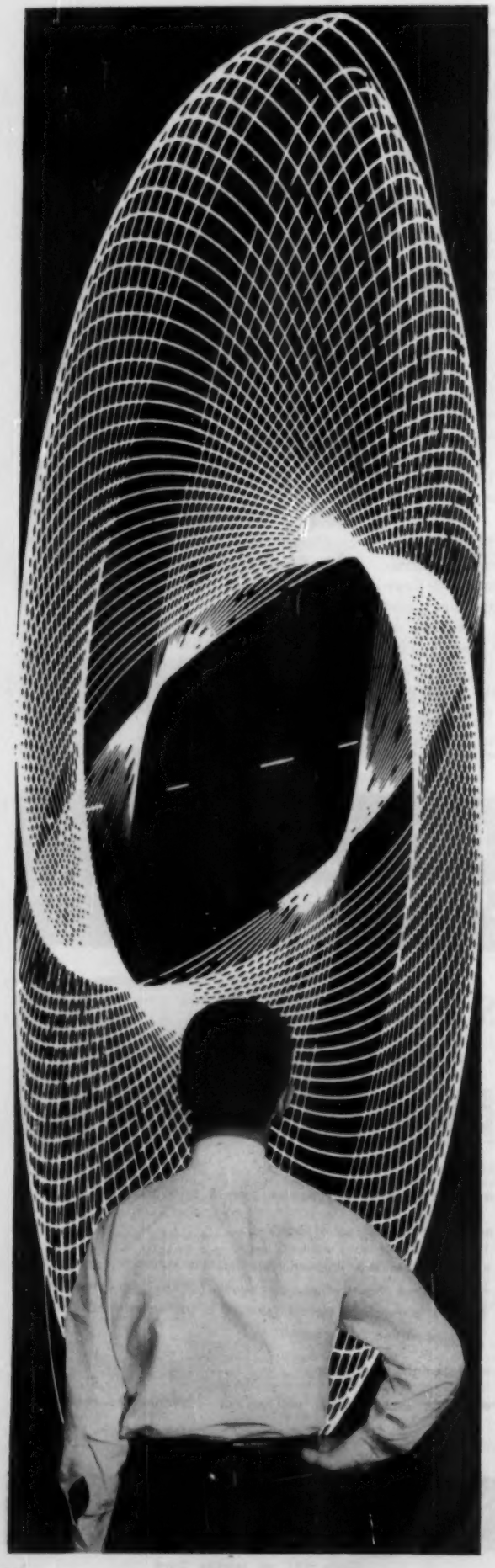

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AUTOMATION abstracts

HOW TO USE SOLID STATE CONTROLS

By C. B. STADUM
Manager
Control Engineering Department
Motor and Control Division
Westinghouse Electric Corp.

IN THE APPLICATION of Cypak elements to industrial control systems, design of the circuit and selection of components are not difficult or complicated tasks, even though a relatively new concept of electrical control is basic to both. Instead, Cypak control systems can be designed quite as readily and as practically as other systems familiar to the control engineer. The design of a typical Cypak control system will show how readily these design procedures conform to general design practice.

Before undertaking this design, however, we should review the symbols we shall employ and refer to some essential characteristics of Cypak elements, *Fig.* 1. The five Cypak elements that will serve as components are known as *And, Or, Not, Memory,* and *Amplifier* circuits. According to their function, an *And* circuit produces an output only if all input signals are present; an *Or* circuit produces an output if any input signal is present; and a *Not* circuit produces an output only if no input signal is present. If an input signal is present, output from the *Not* circuit will cease.

The fourth circuit, the *Memory* circuit, is one which produces an output if an *On* input signal is applied; it will continue to produce this output after the input signal is removed and until a signal from another source switches it off. The fifth, the *Amplifier* circuit, is an element whose function is to drive solenoid valves, contactors, or magnetic chucks. Although amplifier circuits generally include magnetic amplifiers, they may also use relays or electronic switches.

The most recent component is a contactless limit switch which is symbolized as a coil to indicate its basic construction. Since both contactless and conventional limit switches will be considered as components of the overall system, both types are illustrated.

Circuit Development

With these basic details established, a representative Cypak circuit can be developed. On the assumption that an order has been received for a control to operate a drillhead automatically, the steps in control design will include the interpretation of requirements, development of the circuit, selection of components, testing the circuit, and finally, layout of the actual control. This application to a drillhead control serves as an excellent illustration since the operation includes elements found in many varieties of machine tools.

Modes of operation required, *Fig.* 2, provide that in Operation 1 the drill head begins downward movement from its rest position with a velocity that is both variable and controllable; after the drill head reaches its lowest position, it reverses direction and returns rapidly to its initial position. Requirements for Operation 2 are identical with those of Operation 1 except that in the second mode the cycle is repetitive. In Operations 3 and 4, jogging must be possible in both the up and down directions, with the stipulation that jogging cannot occur beyond the limit switches. For Operation 5, the operator must be able to bring about manual or automatic operation in either direction if the drill head is stopped in midposition.

At this point it is worth noting that this graphic representation of requirements for machine operation is ideal for the purposes of the designer. Bar charts of this type are far more useful than a relay schematic diagram, since a relay schematic must be interpreted as a bar chart before the Cypak designer can prepare his logic diagram.

As the first step in the actual design, we will begin by specifying that the system, *Fig.* 3, will include a transformer, fuse, undervoltage protection relay and *Start* and *Stop* buttons for the entire circuit. Contacts on the relay will be used to start the spindle motor and a second *Stop* button will be placed in the circuit ahead of all Cypak components so the operation may be stopped at any time.

Since both *Up* and *Down* operation will be necessary, circuitry for both can be incorporated at this point without any concern for

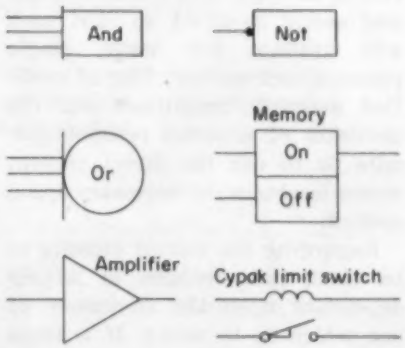

Fig. 1—Symbols representing Cypak elements. A complete discussion of these elements and their functions may be found on Pg. 100, AUTOMATION, Aug. 1955.

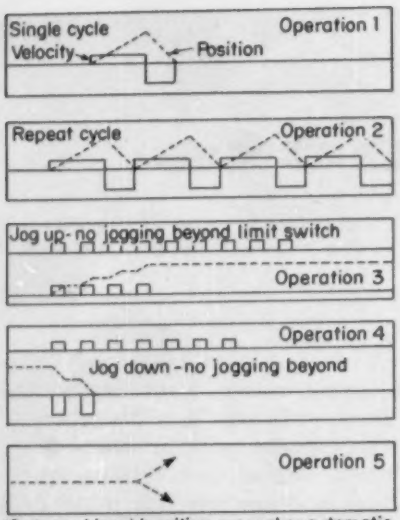

Fig. 2—Modes of operation required for automatic control. In the charts of Operations 2 and 3, the upper axis indicates action called for, the lower axis indicates action obtained.

interlocking. However, in considering a method for reversing the drive motor, we find that an engineering decision is necessary. If the use of alternating current motors is proposed, reversing can be accomplished by the use of reversing contactors and two amplifiers, rated at 50, 150, or 300 watts. If costs are to be kept as low as possible, reversing could be obtained through the use of two preamplifiers and two pilot relays. Since it has been specified for this application that speed control is necessary for the drive motor, and since this motor is relatively small, it is equally possible that a split field, direct current motor can be used. Although magnetic amplifiers are normally used to pass alternating current, they can be slightly and easily modified so that each will produce full wave, single phase, direct current. Use of modified magnetic amplifiers and the inclusion of a series resistor permits us to use the direct current motor to obtain the necessary speed control.

Regarding the output circuits to be used, this decision is largely dependent upon the frequency of use which is to occur. If a large number of operations per minute is required, moving contacts should be kept to a minimum and magnetic amplifiers should be specified, even in applications where relatively large units are necessary. If few operations are required, however, economic considerations favor the use of the low-cost preamplifier with a pilot relay.

As the first step toward circuit interlocking, we specify the inclusion of a *Memory* circuit. To illustrate its function, once the *Up* pushbutton is pressed, the *Memory* circuit will remember this signal and its circuitry will continue to call for *Up* operation after the pushbutton is released. Since the *Memory* element has two positions, pressing the *Up* button causes the signal to be eliminated from the *Down* circuit so that conflicting instructions to the drive motor do not occur. To supplement the *Memory* circuit, *And* circuits are also included; accordingly, each of the motor fields requires two signals for its operation.

Switches

After providing the circuitry necessary to operate the drive motor in two directions, circuitry must also be included to stop the motor when the drill head reaches the end of its travel. This circuitry is achieved by the use of two limit switches, one to limit the *Up* stroke and one to limit the *Down* stroke. Since it is necessary to have a signal when the drill head is at midposition and neither limit switch is supplying a signal, we feed the limit switches through signal-producing *Not* circuits. At the end of each stroke the signal produced by the corresponding limit switch will switch off the *Not* circuit and reverse the electrical condition of the *Memory* circuit. *Or* circuits are now added to the overall circuit to permit the *Memory* circuit to respond to the pushbuttons or the limit switches.

Limit switches suitable to our design are now available in several types. One type, the Westinghouse PLS limit switch, is a small, snap-action switch whose service life and reliability are unusual for switches of this type. If a switch of this type is employed, the circuit can be simplified by making use of the normally-closed switch contacts to eliminate the two *Not* circuits otherwise required.

Also available is a new, contactless arm-actuated switch, *Fig.* 4, that has been developed specifically for Cypak applications. This switch operates as a result of the change of impedance produced in a capsulated reactor when a permanent magnet moves near to or away from the reactor. When the magnet is in position, the core is saturated, but when out of position, the core becomes unsaturated. This switch has only two points at which wear may occur, the main bearing and the roller bearing. Since there are no electrical contacts, the life of the switch can be expected to be many times that of conventional switches.

Still another switch is available to us for inclusion in our design. This new switch, the proximity switch, *Fig.* 5, has no moving parts and, moreover, is completely capsulated. Like the contactless limit switch, the proximity switch makes use of the change in impedance

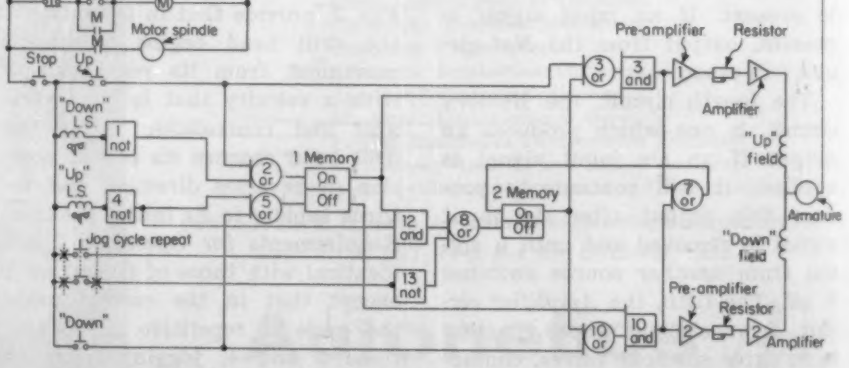

Fig. 3—Schematic diagram of a Cypak control circuit for automatic drillhead drive. This application serves as an illustration of operation of many elements found in a variety of machine tools.

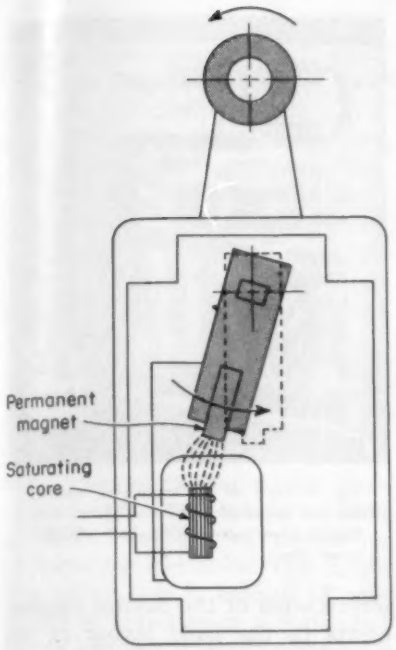

Fig. 4—Diagram of the contactless arm-actuated limit switch which operates as a result of the change in impedance produced when the permanent magnet moves in relation to the reactor.

that occurs when a normally saturated core becomes unsaturated. Normally, a magnet saturates the core but when a small steel bar approaches, flux is shunted away from the coil assembly. The resulting change in impedance is sufficient to provide a change in signal capable of operating Cypak control elements.

Any one of these three switches will be satisfactory for application. A decision will depend only upon the service life that is required. For these three switches, life ranges upward from 10 million operations to an indefinite value.

Special Operating Conditions

Once the limit switches have been selected, it is possible to complete the logic circuit. Since there are several conditions in which the operation may be stopped, a *Memory* circuit must be added to override other *On* signals. Also, since the stopping signal must control both *Up* and *Down* operations, both *Start* and *Stop* signals will be applied through *Or* circuits to the *Up* and *Down* circuits.

After a means has been provided to stop the drive motor, a means to start it becomes the next objective. This is accomplished by

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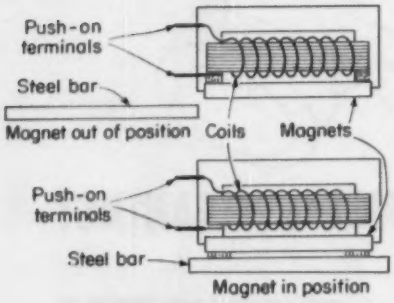

Fig. 5—Diagram of the capsulated, contactless proximity switch which also operated as a result of change in impedance.

the inclusion of an *Or* circuit to activate the *Memory* circuit if normal *Up* or *Down* signals arrive.

One condition for stopping the drillhead drive motor requires that during single cycle operation the motor goes through one full cycle and then stops when the drillhead reaches the top position. This operation requires that three conditions are met: The circuit must be connected for single cycle operation; the drillhead must be moving upward, with a connection established from the *Memory* to the *And* element; and the *Up* limit switch must be operated. When these three conditions exist simultaneously the drillhead drive motor will be switched *Off* when the drill head is at its top position.

As the final step in circuit design, it is necessary to provide a master *Stop* pushbutton for switching off the entire control. If the control is operating according to single cycle or repeat cycle operation, pressing the *Stop* button will break the control circuit; the *Not* circuit prevents the resumption of operation when the *Stop* button is released.

Test and Final Configuration

Once the logic circuit design is complete it is obviously desirable to verify the circuit well in advance of final assembly and test. An efficient way to accomplish this is through the use of a Cypak circuit simulator, an assembly of standard Cypak elements which can be interconnected by patch cords to build up any Cypak control system easily and quickly. Limit switches and pushbuttons are represented in the simulator by toggle switches.

To test the operation of the proposed Cypak control system, selector switches are operated after proper interconnections have been made. If the design under test is correct, indicator lights will glow in a pattern appropriate to the operating sequence of the machine.

After circuit verification, the next step is the transformation of the design into an actual operating control. Since the application we have chosen is intended for machine tool control, the requirements of the National Machine Tool Builders' Association and Joint Industries Conference are applicable and will be observed. To house the control equipment we will specify a wall-mounted NEMA-12 cabinet that is gasketed to exclude oil, and will also specify that door fasteners be of the quarter-turn type which require that a screwdriver be used to turn them.

As the final step in design, the panel layout itself is prepared, *Fig.* 6. In this particular design, accessibility and conservation of cabinet space have received much attention. A new layout for the magnetic amplifiers contributes effectively to both objectives.

In summarizing this sequence of procedures followed for design of an automatic drillhead control, we have progressed from the first interpretation of the control requirements to the final layout of the system. Although this particular application cannot represent all control problems, it does illustrate the basic elements of Cypak system application. In the design of other systems, even those whose requirements are more complex and more exacting, it is very likely that the designer will proceed in fundamentally the same way.

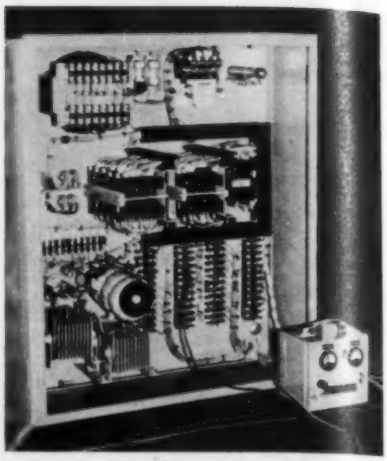

Fig. 6—View of the completed control for the automatic drillhead shows how layout gives accessibility and efficient space use.

From a paper entitled, "Design Procedures for a Representative Cypak Control System" presented at the Westinghouse Machine Tool Electrification Forum in Buffalo, April 1956.

AUTOMATION AFFECTS QUALITY CONTROL

By J. J. JAEGER
Vice President
Pratt & Whitney Co. Inc.

LET'S TALK for a moment of how automation affects the work in the field of quality control. At the same time the revolutionary ideas of cutting tools and machine tools were finding their way into productive use, so too, was the gage engineer active in promulgating the use of improved styles of measuring, indicating and recording equipment. It wasn't many years ago that the mechanical indicator, gage block, the vernier height gage, the plug and ring gage, were the backbone of inspection equipment. A quiet, peaceful, evolution has been occurring to control quality in your field of responsibilities. Whole new families of devices have been made available for various types of gaging operations. As the rolling speeds increased in the steel mills, it became necessary to find ways and means of obtaining continuous gaging information so that miles of scrap would not be produced. Speeds have increased so that it is no longer possible for the clever operator to "mike" the sheet while on the fly.

Today continuous mill gages are used which constantly gage the sheet and with electrical instrumentation record and indicate any

off-gage dimension to the rolling mill operator in values easily read. Applying the principles of feedback, the rolls can be automatically adjusted to correct any deviation.

A whole family of gages has grown out of the Electrolimit comparator unit which is so versatile and reliable in indicating small deviations. This device is important because its information is produced in a form that can be handled automatically for reading or recording or, if required, for automatic control. And, too, the noncontacting air gage has found acceptance in all areas of measurements. Here we find a jet of air emerging from an orifice capable of measuring or indicating deviation. This again is a device that is capable of producing information in a form that can be utilized in many automatic operations.

We might consider some of the types of measuring equipment that are becoming more and more important and that involve the use of radiation. The x-ray gage was the earliest of these forms and today it is rapidly increasing in general usage. Now, to extend this field further, we utilize the developments of the nuclear physicist. Using materials made radioactive in the nuclear reactors of Oak Ridge, we find in general use the Beta-Ray as it emanates from a radio-active piece of strontium carbonate. Radiation type gages are capable of producing information in a form that can be used in automatic machinery.

While the production engineer was striving to reduce the direct labor on any given part, so too, the inspection group began to use new automatic techniques to eliminate individual handling and measuring of components. And, as a further extension of this general thought, automatic classification equipment came into general use. All of you are familiar with automatic classification equipment used for ball bearings, wrist pins, and pistons, connecting rods, and a wide assortment of similar parts that can be processed automatically through gages and segregated into dimensional groups. Or, going a bit further, you are all familiar with complicated pieces that can be gaged and then marked or stamped

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with classifications indicating dimensional information. With these efforts, we have not only eliminated individual handling and measurement of components but we have further improved the quality of our product by grading them so that selective assembly can be done economically. All of this is old information to you. Where can we look for further improvement? What areas do we have to exploit, to satisfy this demand for more and better things?

Predictions for the Future

Now, I venture to gaze into the crystal ball and give you my prediction of where we are heading in many of these phases of inspection and manufacturing. With all of this background in diversified fields, and with the accumulation of knowledge in control, the stage is set for the marriage of two techniques—the technique of the process engineer and the machine tool builder with the technique of the inspector and the gage maker. This can bring forth a broad area of automatic control that can influence our entire concept of manufacturing. With the confluence of these efforts, a machine can be created that can be told what to produce and that can be given the opportunity to correct itself—self-inspection and self-correction, automatic manufacture, automatic inspection and automatic correction of errors.

How will we do it? We'll do it in the same way that the continuous mill gage automatically controls the screw downs so that correct thickness is always being rolled with a minimum of scrap and a maximum of zero tolerance material. This idea is not new; it has been done in the past in simple forms but its application on a broader scale is the thing I look forward to. In the past, we have seen external grinders that continuously measure a part while in process and that stop the in-feed when the gage informs the machine that it has reached the proper dimension. This is a simple application. The gage can be introduced without interference with the grinding wheel; the part is relatively clean and a minimum of vibration is experienced. The operations are relatively slow and the whole equipment can be put together with a minimum of effort.

Let's consider for a moment a slightly more complicated operation where it is impossible to gage during the machining process. Suppose we place the gaging equipment at the exit of the machine so that as each piece is produced it automatically enters the gage and is checked. Acceptable parts may be run down one chute, rejects through a second chute. We could cause the machine to shut down if two successive rejections occur, giving the operator the opportunity in this event to make machine corrections as a result of the readings on the gages.

As a further extension of this principle, suppose, as we gage each piece at the completion of its operation, that automatic reading causes a tool adjustment so that the part size tends towards the center of tolerance. As tool wear occurs, the tool could be gradually advanced, keeping the parts within a narrow tolerance band. Further, when the tool due to wear has advanced beyond desirable limits for quality of the parts or regrind of the tool, a new tool or new cutting edge of the same tool could be brought into play, the slide retracted, and again self-adjusted to find the center of tolerance.

I am sure that, as the opportunity is presented, many unique and ingenious combinations of machine control and inspection devices will find their application in industry. Given the demand and a clear delineation of requirements, it appears to me that virtually any problem, within reason, is capable of at least a partial solution. There remains only the justification of the economics of the situation.

What is the ultimate result of an approach of this sort to automatic operation? I think this approach has the qualities that will produce better and better assemblies. I think it will cause us to change our concepts of manufacturing that involve selective assembly. It would be no modest gain if parts could be produced that would eliminate the need of selective assembly which to me is only an admission that we are capable of inspecting

parts much closer than we can make them. If machinery can be developed which will always tend to make parts in the center of tolerance and within the same spreads that are possible for short periods of time, it seems to me that a considerably more desirable product can be produced, and furthermore, produced at a reasonable cost. I believe systems of this sort can be expected to produce parts of higher quality, with less scrap, and with less exacting skills on the part of the machine operator.

Joint Effort

The solutions to these problems will not be easy, either from a technical standpoint or from a personnel standpoint. Successful installations of this form of equipment will only result from an intense co-operative effort of all of the people involved: the process engineer, the machine tool builder, the inspector, the gage maker, and the shop operating personnel. Each must contribute his knowledge to the pool. Each must give his needs, his desires, and his compromises. But the goal is worthy of the effort since it will contribute measurably to the need for making better parts with less scrap in shorter time.

Although it is interesting to speculate on the future of automatic control, it is also necessary from time to time to become completely practical and consider problems that may be created in industry as the result of the application of these more complex systems. New gains will not be accomplished without some penalties. There will be many heartaches and many failures, but I am sure the results will be worth them.

We need make no apology for automation in industry and for the development and application of more and more complex automatic machinery. There's no bugaboo or mystery about it. All of this comes as the result of ever increasing demands for more things and better things and less expensive things. Certainly there's no evidence that these demands will cease or even ease a little bit.

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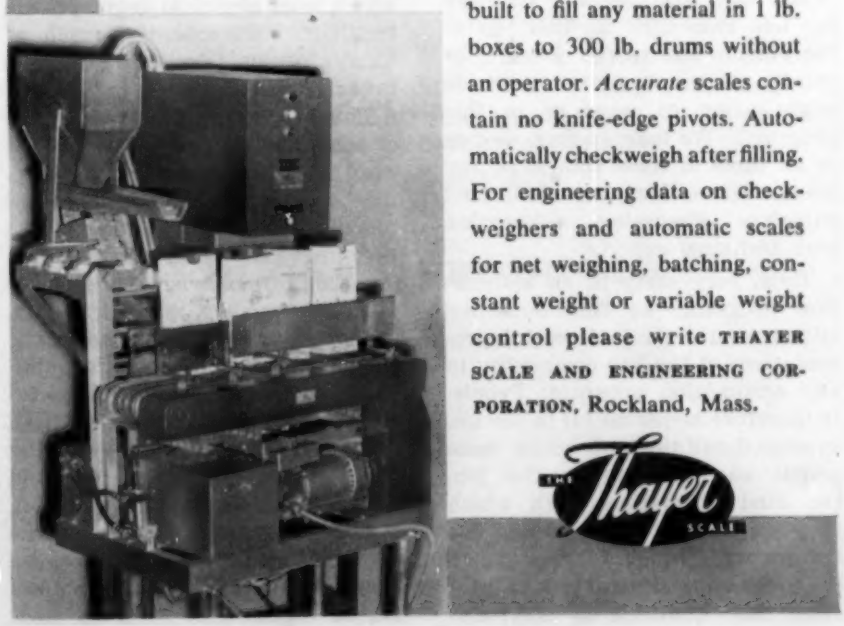
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But we must be conscious at all times of the fact that sound growth in our economy can result only from an intelligent application of equally sound fundamentals; that a better way of living can be achieved only if everyone profits. This comes about by evolution; not by revolution. And I feel that you here can be proud of the fact that you are contributing, each his small mite, to a finer world and a happier way of enjoying it.

From an address entitled, "Automation in Industry" presented at the New England Conference of the American Society for Quality Control, Hartford, Conn. Nov. 1955.

TOOLS OF AUTOMATION

By G. A. NOTHMANN
Manager
Mechanism and Dynamic Research Dept.
Armour Research Foundation
Illinois Institute of Technology

LET US SUPPOSE that you and I have decided to launch an automation program in our company. We have carefully investigated the economic and operational aspects of such a program and are now ready to initiate the engineering program. It is probable that we shall take one of three steps: We shall call in the engineers and research staff of our own company to discuss the program; we may, if our own staff is not available for one reason or another, go to the outside and recruit a staff; or thirdly, we may contact an outside organization to serve us in this program. We may, in fact, do two or all three of these things. In any event, before long we shall find ourselves discussing automation with technical experts.

Thus, very early in an automation program, we find ourselves sitting around the table with representatives of the key commodity in any automation program: People. It therefore seems useful to discuss in some detail the tools which these people should bring to the job, the kind of matters with which they should be experienced, the factors with which they ought to be conversant, if we are to consider them qualified to undertake this task. Automation, like almost all engineering or technological concepts, is extensive; it strongly overlaps many other fields of endeavor and has many features in common with them.

As we look into the tool kit of an automation engineer, we expect to find that many of his tools are familiar to us; they are similar to many which we find in other fields of technology. However, even though it is dangerous to generalize in this area, we are justified in considering certain tools as typical for an automation approach.

The first tool of which we become aware, almost as soon as automation is mentioned in technical company, is the tool of language. The term automation itself is of relatively recent origin, and today we know reasonably well what it represents. There are many other common terms, such as feedback, gain, digital and analog computation, response characteristics, with which an automation engineer should be familiar and, more importantly, which he should be able to explain in simple terms to the uninitiated. About 10 or 15 years ago, when renewed emphasis was placed on automation development, and, particularly, when many of the modern techniques of servomechanisms and electronics were applied to automation, it was found that much of the theory of these new systems was already well developed. These methods were well advanced in the field of communication and network theory with which most electrical engineers are familiar. Consequently, much of today's automation terminology is taken from this area.

This fact, indeed, can be a source of some frustration to those of us who bring a mechanical engineering background to problems in automation. We may perhaps take encouragement from a famous reply which O. Heaviside, one of the fathers of modern network theory, gave to a group of mathematicians. He was questioned about the validity of applying his methods, useful and accurate though they had been found to be, without providing rigorous mathematical proofs and derivations. His classical question, in answering this criticism, was "Should I refuse my dinner because I do not fully understand the process of digestion?" It is, in fact, true for many of the seemingly complex terms and techniques of automation that, once some familiarity with them has been achieved, they prove extremely practical and represent an important tool which simplifies automation design.

The technical advances in automation of the past 10 years have been accompanied by an ever increasing use of a second design tool, theoretical analysis. Two common characteristics of automation systems are higher speeds and variability in operation, i.e., their ability to change their operating parameters in accordance with a dynamic input signal. This has made the requirement for thorough theoretical analysis and, based on it, prediction of performance at the "drawing board" stage, very vital. The need has brought about a large number of theoretical design tools which have been discovered, rediscovered, or merely adapted to specific applications.

Among the many new theoretical techniques developed in recent years, one technique has achieved special prominence. Its uniqueness justifies particular attention. Since the parameters of most automation systems, characteristically, are variable, it would be uneconomical and time consuming to construct models of each version corresponding to each set of these parameters. A technique which obviates the construction of actual machines during the design process is the analog technique. A designer brought up in more traditional methods of designing machines may well be startled to find that many machines in an automation system can be analyzed by designing an electric circuit and, by turning certain dials on a computer, predicting the performance of the machine under various conditions.

Flexibility in applying new design rules is borne out in the type of components which are selected in automation systems. Typical conventional automatic machines include many cams, linkages, and similar fixed parameter components. In many modern automation systems, these are augmented by hydraulic cylinders, actuators and electric controls, since these lend themselves more readily to changes in operation in accordance with programmed input signals.

Development of new theoretical

design tools has been matched by a concurrent development of experimental methods, providing another design tool for automation, experimental techniques.

In a typical automation system using feedback control, measurement of output motion or performance is used for two purposes: To obtain a direct record of performance, and to feed a signal of output back to the controller for comparison with the input command and dynamic correction. Measurement and programming is thus a vital aspect of designing an automation system and may be called a further design tool.

Broad Background Necessary

The array of technical disciplines combined in automation technology not only shows some of the interrelations between automation and other fields; it also indicates the breadth of technical education which is required of engineering students to provide proper training for the design of automation systems. A number of years ago, graduating seniors in engineering were occasionally and appropriately advised that much of the course work included in undergraduate curricula was not directly applicable to practical engineering activity; a considerable portion of the material acquired in mathematics, kinematics, electronics, and dynamics courses was to be laid aside, and professional growth would result primarily from practical experience on the job. Today's graduating engineering students, on the other hand, can confidently be assured that the technical and scientific knowledge presented in our engineering schools is pertinent to the design of the complex machines which form our modern automation systems. Our present-day advice to a recent graduate might well be, "Pack up all the technical tools you have been given in school; most of them will be vital in helping you become a useful member of any team designing an automation system."

From a paper entitled, "Design Tools for Automation" presented at the Armour Research Foundation Conference on Automation for Executives at Illinois Institute of Technology, Chicago, Feb. 1956.

Engineers...

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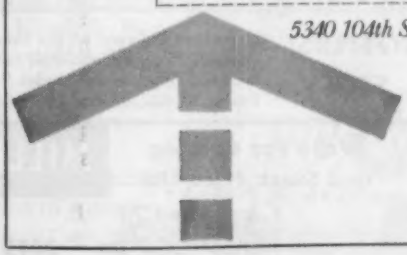

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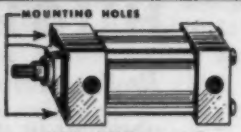
See Miller Bulletins A-105K (Air) and H-104K (Hydraulic) for Complete Dimensions and Engineering Data on these "in-stock" sizes and other Custom Miller Cylinders in bores up to 20" and strokes up to 22 feet.

"IN-STOCK" MODELS

"A" Signifies Miller 200 psi Air Cylinders; "H", 2000 psi Hydraulic Cylinders. Interchangeable Mountings Are Shown In Red On Drawings.

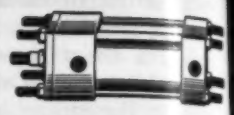
A61 and H61
Flange Mounting on Rod End
(A61 not available in 8" bore)

A62 and H62
Flange Mounting on Cap End
(A62 not available in 8" bore)

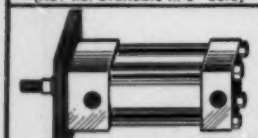


A63—8" Bore only
Flange Mounting on Rod End

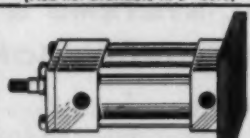
A64—8" Bore only
Flange Mounting on Cap End



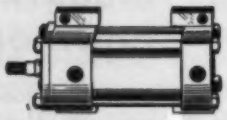
A50 & H50—Tie Rods not extended beyond nuts.
A51 & H51—Tie Rods extended both ends (shown).
A52 & H52—Tie Rods extended. Cap End only.
A53 & H53—Tie Rods Extended. Rod End only.
A54 & H54—Two Tie Rods extended at both ends.



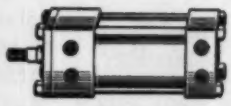
H65—Hydraulic Only
Flange Mounting on Rod End



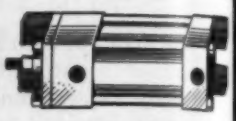
H66—Hydraulic Only
Flange Mounting on Cap End



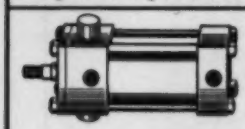
A72 and H72
Side Lug Mounting



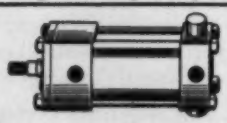
A74 and H74
Side Flush Mounting



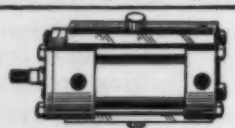
A77 and H77
Side or Foot Mounting



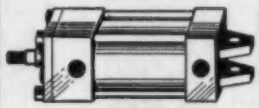
A81 and H81 Trunnion Mounting on Rod End



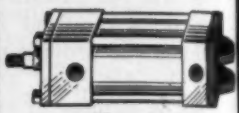
A82 and H82 Trunnion Mounting on Cap End



A83 and H83 Trunnion between Head and Cap
(one week delivery)



A84 and H84
Pivot Mounting



A86 and H86
Pivot Mounting

IN STOCK BORES in Inches

	Bores	Rod Dia.	Rod Turn Down & Threads	"IN-STOCK" STROKES (in inches)																				
AIR	1½	⅝"	7/16-20	Cushioned			3	4	5	6	7	8	9	10	11	12								
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12								
	2	⅝"	7/16-20	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	2½	⅝"	7/16-20	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	3¼	1"	¾-16	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	4	1"	¾-16	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	5	1"	¾-16	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	6	1⅜"	1-14	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	8	1⅜"	1-14	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
HYDRAULIC	1½	⅝"	7/16-20	Cushioned			3	4	5	6	7	8	9	10	11	12									
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12									
	2	1"	¾-16	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	2½	1"	¾-16	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	3¼	1⅜"	1-14	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	4	1¾"	1¼-12	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	5	2"	1½-12	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36

① "A" and "H" Models 82, 84 and 86 with strokes over 18" require stop tubes.

Column strength requires larger diameter piston rods for the following:

Air Cylinder Models A82, B4, and B6 with strokes inside area (1), when operated at 100 psi and over;

All hydraulic models with strokes inside area (2) and Models H82, 84, and 86 with strokes in area (4), when operated at 2000 psi and over;

④ Models H82, 84 and 86 with strokes inside area (3), when operated at 1000 psi and over.

③ ② Depending upon Trunnion Pin location, "A" and "H" Models 83 with standard diameter piston rods can have longer strokes than Models 82, 84 and 86.

See Miller File #251 for oversize piston rod and stop tube requirements.

BOOSTERS IN STOCK

Immediate Delivery on the following Miller 25 to 1 Ratio Boosters (80 psi air input produces 2000 psi hydraulic oil output): Model B4, 5" bore, 1" dia. ram, 6" and 12" strokes; Reciprocating Booster Model DA77-RBA8, 5" bore, 1" dia. ram, 6" stroke. Also Booster Tanks, 5" dia., 6" and 10" heights.

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AUTOMATION

patents

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Components

AUTOMATIC LUBRICATING SYSTEMS FOR SHAFTS

Shaft interior fitted so as to draw lubricant from a supply and discharge it at the periphery of the shaft. Rotating with the shaft is a grooved collar having a radial jet opening that facilitates return of lubricant to the supply. Patent 2,743,788 by Willy Borberg, assigned to International Projector Corp.

ELECTROMAGNETIC PLATE CLUTCH

Clutch elements are actuated toward one another by controlled magnetism and a magnetic fluid mixture is pumped through slots between the friction surfaces to reduce the magnetic reluctance of the linings. Patent 2,738,044 by Martin P. Winther, assigned to Eaton Mfg. Co.

AUTOMATIC POSITIONING DEVICE

Relative positions and angular orientation between two objects is maintained by means sensitive to the time interval between propagation and reflection of ultrasonic waves through a fluid medium between the objects. Patent 2,743,429 by Donald C. Erdman and George B. Greene, assigned to Electrocircuits Inc.

• • •

Controls

AUTOMATIC CURVE FOLLOWER WITH VIBRATING STYLUS

Follower adapted to track the boundary between conductive and nonconductive portions of the surface of a chart. Patent 2,744,224 by Hendrik W. Bode, assigned to Bell Telephone Laboratories Inc.

HYDRAULIC CONTROL SYSTEM FOR DUPLICATING TOOLS

Circuit utilizing three interdependent hydraulic cylinders is arranged with control valves in a manner that controls the movement of a cutting tool

STOP PIPE THREAD LEAKS ››› with

TRU-O-SEAL

TEFLON SEAL

Does away with messy pipe "dope" compounds!

PAT. PENDING

. . . Eliminates valve and pump damage caused by overtightening of leaky joints.

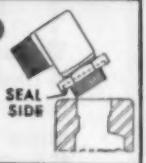
. . . "TEFLON" SEAL is immune to ALL hydraulic fluids and to steam, air, water, solvents and practically all gases and chemicals!

. . . Withstands temperatures from —100° F. to plus 500° F.!

. . . Fully field tested and proven by leading manufacturers!

EASY INSTALLATION!

1 Thread TRU-O-SEAL on pipe or fitting (no messy pipe "dope" needed).



2 Thread pipe or fitting 4 threads into port. Point in desired direction.

3 Tighten TRU-O-SEAL to complete leakproof assembly (only light torque required).

TRU-O-SEAL stops present pipe thread leaks instantly, prevents future leaks, saves cost and labor of special or welded fittings. For 3000 psi operation (15,000 psi minimum proof pressure). Comes in ⅛" to 2½" pipe thread sizes.

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Flick-Reedy Corporation

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←Circle 598 on Inquiry Card

Circle 599 on Inquiry Card

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The new Peerless explosion-proof motor is Underwriters' approved for refineries, gasoline bulk plants, paint factories, grain elevators and other Class I and II hazardous locations where explosive vapors, fumes or dust exist. Single phase and polyphase designs range in size from 1 HP to 30 HP. Motors have ball-bearing construction. They are cooled by air drawn across the motor toward the driven machine by an external fan. Heat generated by the driven machine is not drawn across the motor. Our engineers, working with your engineers, can design any special mountings required to meet your application. Submit your requirements to Peerless. We'll help you select the explosion-proof motor that powers your equipment best.

ELECTRIC MOTOR DIVISION

THE *Peerless-Electric*® COMPANY

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Circle 600 on Inquiry Card

in response to movement of a stylus-operated valve. Patent 2,743,584 by Orel Le Roy Rosebrook, assigned to True-Trace Corp.

• • •

Data Processing

INFORMATION STORAGE DEVICES

Apparatus comprises a cell having a first portion which is of photoconductive material and a second portion of a photovoltaic material capable of changing the direction of its photocurrent output. The portions are in electrical contact and an electrode is in contact with each portion. Patent 2,743,430 by Melvin L. Schultz and George A. Morton, assigned to Radio Corp. of America.

MULTIDIMENSIONAL MAGNETIC MEMORY SYSTEMS

Apparatus for registering information magnetically by transmission of electrical pulses has several bistable magnetic cores each having a plurality of coils linked with it. A unique word line may be selected by the coincident selection of a unique word line circuit in each of two matrices. Patent 2,740,949 by Richard G. Counihan, Munro K. Haynes and Gordon E. Whitney, assigned to International Business Machines Corp.

• • •

Handling

INDEXING MECHANISM WITH FRICTION DRIVE

Parts frictionally engaged by a rotatable element are indexed by movement into engagement with a continuously rotating element. Patent 2,738,187 by Kenneth R. Johnson, assigned to Bartelt Engineering Co.

SHEET HANDLING MEANS

Sheet pick-up device engages a sheet and parts it from a stack, holds it in such a position that other mechanisms can detect the number of sheets held and return excess sheets to the stack. Patent 2,743,923 by Michael Watter, assigned to the Budd Co.

AUTOMATIC CONVEYOR SYSTEM FOR BILLETS

Billets carried by a continuously moving main conveyor actuate means to transfer individual billets to an intermediate conveyor for automatic performance of a reducer roll operation. Patent 2,737,834 by Cornelius H. Coughlin, Robert Lawrence and Charles W. Mote, assigned to Chrysler Corp.

• • •

Machines

BAG MAKING MACHINE

Bags are formed from tubular thermoplastic material by passing around a perforated hollow drum under spaced heated wires which sever the material

into bags. Material is held on the drum by vacuum in the drum and bags are removed by blowing air out of the drum at the discharge point. Patent 2,737,859 by Herbert S. Allison, Raymond I. Hakomaki and Frank B. Jewett Jr., assigned to General Mills Inc.

APPARATUS FOR MANUFACTURING A CEREAL FOOD PRODUCT

Means for shredding cooked cereal grain and forming the shreds into lattice-like networks which are superimposed; slit into ribbons; cut and formed into hollow bodies, and the edges of which are sealed together where cut. Patent 2,743,685 by Douglas Hale and Ellsworth J. Carpenter, assigned to Ralston Purina Co.

MACHINE FOR DISPENSING PREDETERMINED QUANTITIES OF MATERIAL IN LOOSE OR COMPRESSED FORM

Quantity of powder is dispensed by mechanism having tubular pins separated by a gap giving the required volume. The gap is filled from a supply container which slides on the pins and is followed by a sleeve. Patent 2,738,550 by Walter R. Groves, assigned to British Industrial Plastics Ltd., London, England.

MULTIPLE STAPLING MACHINE

Framework supports a work table and a vertically movable platen that carries a plurality of staplers. Patent 2,743,442 by Clarence J. Davies, assigned to National Automotive Fibres Inc.

• • •

Process Design

ELECTROLYTIC CUTTING OF METALS

This method to cut metals electrolytically comprises defining the area, supplying electrolyte to the region and creating an electrolyzing current through a cathodic cutting electrode and the electrolyte while establishing an auxiliary voltage in electrodes disposed around the area. Patent 2,739,935 by George L. Kehl, and Irving Moch Jr., assigned to the United States of America.

PROCESS AND APPARATUS FOR DRYING SHEET MATERIAL

Liquid adhering to the surface of a moving web is detached by supporting a portion of the web for membrane-like vibration and vibrating it with impinging sound waves. The droplets are carried away by a current of air. Patent 2,740,202 by Arthur A. Fowle, assigned to Ultrasonic Corp.

METHOD FOR CONTINUOUS CASTING OF METAL

Molten metal is poured continuously at a constant rate into one end of a mold which reciprocates. Advance stroke of the mold is such that there is no relative motion between metal and mold. Patent 2,743,494 by Irving Rossi, assigned to Continuous Metalcast Co.

POSITIONS AVAILABLE

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AUTOMATION new books

DYNAMICS OF MACHINERY

By James B. Hartman, professor of mechanical engineering, Lehigh University; 283 *pages,* 6 *by* 9 *inches, illustrated, clothbound, published by McGraw-Hill Book Co. Inc., New York; available from* AUTOMATION; $7.50 *postpaid.*

This text is written for advanced students and mechanical engineering graduates. Emphasis is placed on the development of techniques for solution of dynamics problems in modern high speed machinery. Covered are applications of principles to solve dynamics problems in automatic control systems as well as vibrating and rotating machine elements and engines. Problems are included with each chapter.

TRANSISTOR ELECTRONICS

By Arthur W. Lo, Richard O. Endres, Jakob Zawels, Fred D. Waldhauer and Chung-Chih Cheng; 521 *pages,* 5½ *by* 8¼ *inches, illustrated, clothbound, published by Prentice-Hall Inc., New York; available from* AUTOMATION; $12.00 *postpaid.*

Physical concepts behind transistors are explained, and the principles governing transistor operation are discussed. Emphasis is placed on a basic understanding of the circuit aspects of transistors. This book is written as a reference for electronics engineers and advanced students. Similarities and differences between transistor and vacuum tube circuits are included with the warning that literal following of direct analogies may overlook unique possibilities of the transistor.

OFFICE WORK AND AUTOMATION

By Howard S. Levin; 203 *pages,* 5¾ *by* 9 *inches, illustrated, clothbound, published by John Wiley & Sons Inc., New York; available from* AUTOMATION; $4.50 *postpaid.*

Office work is described by the author as information handling involving collecting, recording, processing and utilizing information. Common language machines and their contribution to initial handling of information are explored; electronic computers and their effect on information processing are discussed; and methods of information use, such as operations research, are examined.

Association Publications

THE 400 AMERICAN STANDARDS IN THE ELECTRICAL FIELD

Paperbound, 60 *pages,* 8½ *by* 11 *inches; available from American Standards Association,* 70 *East* 45 *St., New York* 17, *N. Y.; Free.*

Index and short description of each American Standard in the electrical engineering field are given. The booklet also covers International Electrotechnical Commission recommendations and lists projects of the Electrical Standards Board. General information on standards organizations is included as well.

ELECTRONICS IN BUSINESS: A CASE STUDY IN PLANNING

Paperbound. 139 *pages,* 6 *by* 9 *inches; available from Controllership Foundation Inc.,* 2 *Park Ave., New York* 16, *N. Y.;* $4.00.

Comprehensive report on the investigation, purchase, and application of electronic accounting equipment by the Port of New York Authority. It is pointed out that their operations are comparable in many ways to a medium size private company. Detailed information is given on the Port Authority, purchase negotiations, equipment specifications, and personnel selection and training for the accounting program.

Government Publications

Symposium on Television Training and Training Research. *Report* PB 111647 *by Joint Panel on Training and Training Devices;* 152 *pages; available from Office of Technical Services, U. S. Department of Commerce, Washington* 25, *D. C.;* $4.00.

Representatives of military services and universities discuss the advantages of television in mass and long distance educational programs, in teaching specific skills, and in orientation and morale building. Suggestions are offered on program construction, choice of personnel, mechanical equipment, training aids, economy of operation, and methods of projection.

A Survey of Domestic Electronic Digital Computing Systems. *Report* PB 111996 *by Martin H. Weik, Ballistic Research Laboratories, Aberdeen Proving Ground;* 271 *pages; available from Office of Technical Services, U. S. Department of Commerce, Washington* 25, *D. C.;* $4.75.

Report of a survey of 84 systems describes each system and details system designs, applications and characteristics. Operation, reliability, precision, storage capacity, and instruction codes for different systems are also covered. Prices and approximate delivery times are given. Survey was compiled from questionnaires sent to domestic manufacturers and users. A bibliography, list of domestic manufacturers, and a glossary are included.